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The North American Species of *Calocalpe* Hübner (Lepidoptera, Geometridae)

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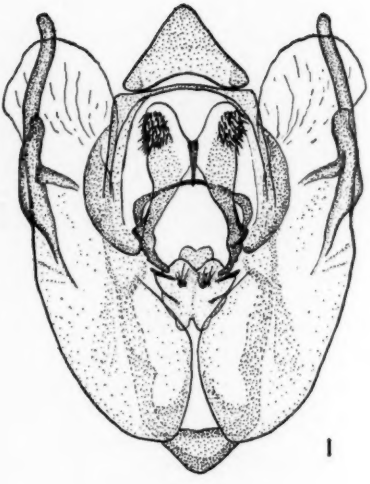
Inconsistencies in larval habits of the Nearctic *Calocalpe* population have been known to lepidopterists of eastern North America for over a decade, at least since the publication of *The Lepidoptera of Nantucket and Martha's Vineyard Islands, Massachusetts* by Dr. Frank Morton Jones and Mr. Charles P. Kimball (Nantucket Maria Mitchell Assoc., IV, 1943). In writing of the occurrence of *undulata* on Martha's Vineyard, Dr. Jones mentioned "solitary larvae, identified by breedings, occasional on *Azalea*". Since only the common gregarious larvae on cherry were known up to that time and always considered as representing an American variant of *undulata*, the report of a solitary larva on a totally different food plant sounded interesting. This was drawn to my attention by Mr. Laurence R. Rupert of Sardinia, N.Y., who did so much to inspire my interest in Lepidoptera in earlier years. On a collecting trip with him to Martha's Vineyard in 1947, one of the things sought for was the *Calocalpe* mentioned by Dr. Jones. We did not find any, but since that time Dr. J. McDunnough and I on a number of occasions have bred specimens from solitary larvae on Rhodora at Halifax. Since Rhodora and *Azalea* are closely related, I assume this to be the same as the Martha's Vineyard species. Dr. McDunnough bred one from a larvae on *Spiraea*, the specimen emerging just in time to be mentioned in this paper. On another occasion I bred one from a single larva on willow, undoubtedly also the same species, and this provided the first clue to its relationship with the Palaearctic willow-feeding *undulata*.

Specimens of *undulata* were obtained from Europe and numerous slides made for comparative study of both male and female genitalia. It became clear that two distinct species were involved, the North American one with larva on Rhodora, *Azalea*, *Spiraea* and willow being conspecific with true *undulata* of Europe, and the better known American population with gregarious larvae on black cherry a new species, which I describe in this paper. Adults of the two *Calocalpes* are almost identical in appearance, thus adding to our known fauna another remarkable pair of so-called "sibling" species.

Nomenclature—The combination *Hydria undulata* appeared first in Hübner's Tentamen (1806), but since this work was ruled invalid by Opinion 97 issued by the International Commission on Zoological Nomenclature in 1926 (Smithsonian Miscellaneous Publications 73, No. 4: 19-30), we must examine the subsequent published works of Hübner to determine its validity.

In the *Systematisch-Alphabetisches Verzeichnis* of 1822 *Hydria* is used for *undulata*, but along with it are included 18 other species. This validates the name *Hydria*, but cannot be considered as restricting it to any one of the 19 species. Unless it can be shown that some subsequent author designated *undulata* as generotype, I prefer to use the name *Calocalpe*, which Hübner proposed for this species soon after in the *Verzeichnis bekannter Schmetterlinge*, 330, 1824-25, and which is monobasic.



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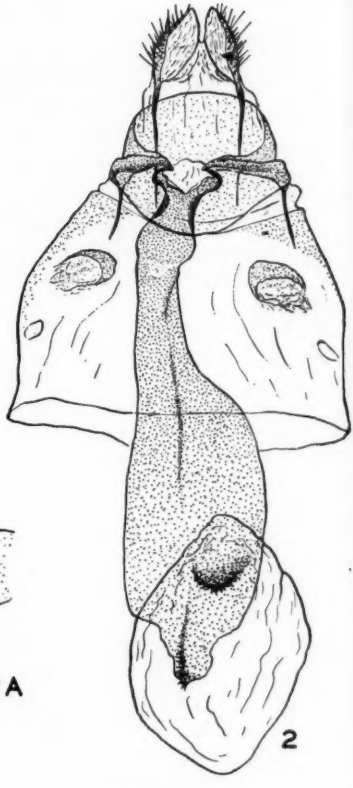

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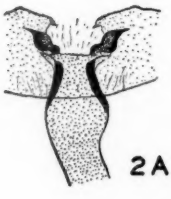

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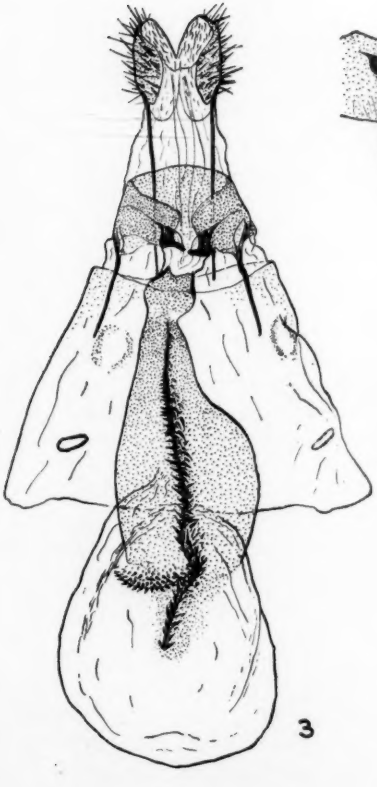

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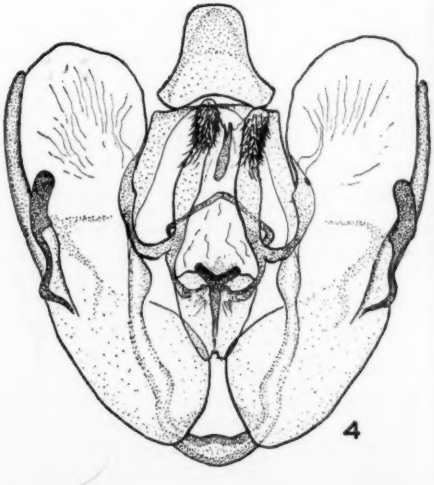

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Calocalpe undulata L.

Geometra undulata

Linnaeus, Systema Naturae, 524, 1758.

Maculation—It is scarcely necessary to give a detailed description of this well known species. North American examples, including the ones we bred, match those from England exactly, except that the latter tend to be a little paler and browner in coloring. The brown of New World examples is somewhat grayer in tone. The sexes are alike. Three out of four specimens before me from Ketchikan, Alaska have a noticeably dark median band and probably represent the beginnings of a race.

Expanse—Eastern specimens correspond in size to the British ones, 24-31 mm. Some western ones are larger. Those from British Columbia measure up to 33 mm., and examples from Arizona and New Mexico are largest, expanding up to 37 mm.

Male genitalia—(Figure 4). The male genitalia of the Old and New World populations are indistinguishable, but considerable variability may be seen even among examples from the same locality. Characteristic features are found in the shape of the uncus and structure of the juxta. The uncus is typically broad and rounded as illustrated, or in extreme cases almost truncate. Rarely it may be somewhat pointed, approaching the form found in the cherry feeder. An entirely reliable character of *undulata* is the heavily chitinized trigonate armature of the juxta. This curious structure is Y-shaped and stands out conspicuously. It is not present or thus developed in the juxta of the other species. The aedoeagus is of simple form, without spines or cornuti, and has been omitted from the drawings.

Female genitalia—(Figure 3). This drawing was made from a specimen taken in the Jemez Mts., New Mexico (A.M.N.H.), but shows characters typical of the species wherever it occurs. The female genitalia consist essentially of a moderately chitinized eighth segment bearing the ostium, a large ductus bursae, heavily chitinized and divided for most of its length by a variably spinose septum, and a membranous bursa copulatrix bearing a crescent-shaped ventral signum armed with small spines. The ductus bursae is concave dorsally, but this does not show well once the genitalia are mounted. The ductus seminalis is apparently small and obscure; I must admit I was unable to find it. In addition to its pair of spiracles, the seventh segment bears a pair of ventro-lateral depressions, marked by faintly chitinized rings. In *undulata* these are not as noticeable as in the following species, in which they form regular pouches. Conversely, the spiracles in *undulata* tend to be slightly better defined than in the other species. The ductus bursae of *undulata* is much shorter and stouter and the ovipositor lobes protrude farther than in the other species. Also, the short membranous connection with the ostium seems to be characteristic. The spinose septum of the ductus is not a good character, as it may in either species be weak and interrupted, very much as it appears in figure 2.

Larva—*Undulata* larvae vary considerably but are always solitary in habits. Two different descriptions follow, based on living specimens. The species is single brooded.

Fig. 1. *Calocalpe prunivorata* n. sp., holotype ♂, genitalia.
Fig. 2. *Calocalpe prunivorata* n. sp., allotype ♀ genitalia.
Fig. 2a. *Calocalpe prunivorata* n. sp., normal ostium of ♀ genitalia. Greenport, Long Island.
Fig. 3. *Calocalpe undulata* L., ♀ genitalia. Jemez Mts., N.M.
Fig. 4. *Calocalpe undulata* L., ♂ genitalia. Cascapedia Road, Gaspé, bred from willow.

(1) This description was based on several larvae found on Rhodora (*Rhododendron canadense*) at Halifax, N.S.,. tying the leaves together to form a shelter in typical larentiine fashion. Ground color dull green to yellowish; greener dorsally, tending to dirty yellowish laterally, posteriorly and intersegmentally when the skin folds overlap. These larvae were without the dark slate-gray dorsal area characteristic of the cherry feeder, and in its place there was only a pair of weakly pigmented, brown dorso-lateral lines, becoming somewhat more definite towards the head and again posteriorly where they extended down the outer sides of the last pair of prolegs. These lines varied greatly and in some examples were almost wholly wanting. Positions of the mid-dorsal and dorso-lateral (where missing) thinly lined in a shade of green darker than the ground. Yellowish lateral lines just above and below the minute black spiracles were diffuse and tended to merge along the spiracular zone separating them, giving the effect of one broad, pale yellow lateral line contrasting with greener dorsal and ventral areas. There was a very weak yellowish mid-ventral. Minute unpigmented tubercles (pinacula) occurred laterally and ventrally on both the thoracic and abdominal segments, but these were less distinct than in the other species and could be seen only under the binocular. Segments A_1, A_2, A_3, A_4 and A_5 each bore a total of 16 such pinacula. The skin was of a smooth but dull texture, thinly clothed with minute hairs. Head shiny orange-brown with blackish markings laterally and dorsally. Narrow, dark-pigmented cervical plate. Thoracic legs at least partially black; abdominal legs concolorous with ventral area. Maximum length when extended about 19 mm.

(2) This larvae was feeding on willow about 45 miles up the Cascapedia Road, Gaspé Peninsula. Ground color pale dull yellow. Dark brown dorso-lateral lines complete and distinct, being about one third the width of the space between them. This space—the dorsal area—orange. Thoracic legs decidedly black. Otherwise like the above.

In considering the larva of European *undulata*, I have had nothing but several published descriptions and illustrations to go by. Curiously, it appears that European larvae are colored more like those of our gregarious cherry feeder, with a very pronounced dark dorsal area. Yet they are solitary and feed on willow, thus approaching in habits our Rhodora larvae that apparently at times will also take willow. The discrepancy in coloring can only be ascribed to geographical variation, which in this instance has developed noticeably in the larva but scarcely at all in the adult.

Pupa—Light chestnut brown, smooth. Under the binocular the abdominal segments are seen to be pitted; all other surfaces of a slightly wrinkled texture. Cremaster forked, the two prongs normally straight, with three pairs of hooks arising dorso-laterally from the conical base.

Food plants—Rhododendron canadense, Spiraea, Azalea, Salix.

Distribution—Palaearctic and nearctic; northern. In North America it occurs throughout the Canadian and Hudsonian zones from the Avalon Peninsula of Newfoundland to Vancouver Island and Alaska, southward in the Rocky Mountains to the San Francisco Peaks and White Mountains, Arizona and the Jemez Mountains, New Mexico, and in the coast ranges at least to Mariposa Co., California.

Flight period—May 31—August 17. The earliest record is one from Fernie, B.C., and the next earliest (June 4) is a record from Halifax Co., N.S. The peak period is through late June and most of July. The August examples are mostly worn stragglers.

Material examined—Specimens: 135; slides: male, 33; female, 5.

Nomenclature—The name *undulata* has been attributed erroneously to Hübner by some authors (Packard, Forbes), but was published almost 50 years earlier (as *Geometra undulata*) by Linnaeus. The description was probably republished in the various editions of *Systema Naturae*, as several different page references occur in the literature. Unfortunately these are not available to me. I do note, however, that it was republished in the de Villers edition, *Caroli Linnaei Entomologia, Faunae Suecicae Descript.*, etc. under the date 1789, which alone would antedate Hübner's use of the name. Hübner himself attributes it to Linnaeus.

***Calocalpe prunivorata* n. sp.**

Male—Almost identical to *undulata*, but in the east averaging a little larger, somewhat brighter, and better marked. Ground color light brown variably shaded with dark brown, especially sections of the median band and subterminal area, the latter tending toward a contrasting reddish-brown tone. Primaries with a maximum of 15 dark transverse waved lines plus a whitish, dentate subterminal. Secondaries with up to 8 transverse lines all, except the whitish subterminal, tending to be more diffuse than those of the primaries. All of the lines, including those of the secondaries, tend to be brighter and better defined than in American specimens of *undulata*. *Prunivorata* is closer to European *undulata* in maculation. Color and markings of thorax and abdomen as in *undulata* but brighter.

Female—Like the male but often larger.

Expanse—Holotype: 30 mm.; allotype: 33 mm.: others: 27-35 mm.

Holotype—♂, McLean Bogs Reserve, Tompkins Co., N.Y., June 17, 1953 (J. G. Franclemont).

Allotype—♀, Ithaca, N.Y., June 8, 1946 (J. G. Franclemont).

Paratypes—26 ♂ ♂, 7 ♀ ♀, Ithaca, McLean Bogs Reserve, Horseheads, Colden, Ohio (Herkimer Co.), Uncas Road (Raquette Lake), Allegany State Park, Crystal Lake (Cattaraugus Co.), N.Y., May 23—August 21, mostly in June and July (J. G. Franclemont, L. R. Rupert).

The holotype, allotype and most of the paratypes are being returned to the collection of Dr. J. G. Franclemont at Cornell University, from which paratypes will be distributed to most of the major collections in the United States and Canada.

Male genitalia—(Figure 1). Similar to those of *undulata* except as follows: Uncus normally tapering to a somewhat pointed apex, not broadly rounded as in *undulata*. Juxta of different form and without the strongly chitinized Y-shaped armature.

Female genitalia—(Figures 2, 2a). There is a slight abnormality in the genitalia of the allotype which was not noticed until the drawing of figure 2 was begun. It shows the lateral apices of the ostium as incurved; whereas normally they are excurved, and figure 2a is included to show how this structure appeared in all other specimens examined. In other respects the genitalia of the allotype are typical. In *prunivorata*, the ovipositor lobes are closer to the ninth segment, the ductus bursae is decidedly longer, and the ventral pouches or depressions in the seventh segment more conspicuous than in *undulata*.

Larva—always in large nests formed by tying the leaves together on terminal shoots of black cherry. One of the earliest references to the life history occurs in a note by Geo. D. Hulst, *Entomologica Americana*, Vol. II, p. 162, 1886, in which he quotes part of a letter from Mr. David Bruce of Brockport, N.Y., as follows: "Last year all the choke cherry trees were infested with larvae that

webbed together the terminal leaves on most of the long branches, completely enveloping them with a bag. Short stumpy larvae with reddish head, and with dull green and white lines down the body, fed inside the webs, in numbers varying from 30 to 100. I saved quite a lot, and they emerged *Hydria undulata* Linn." I have found the larvae on nothing but black cherry, *Prunus serotina*, and feel that Bruce's reference to choke cherry might have been in error. His description of the coloring of the larvae does not quite fit those I have seen, but appears to refer to the summer brood, which may not occur in the northern part of its range. Forbes describes the two broods thus: "Fall brood when full grown black above with yellow-brown head, about 3 pair of fine pale lines, and yellow-green underside; summer brood smaller, the ground of the dorsum alternately paler and darker olive, separate by the fine pale lines".

My own description of larvae collected in Nova Scotia agrees essentially with that of Forbes's fall brood, and is as follows: Ground color pale greenish-yellow. Contrastingly dark slate-colored dorsal area composed of 5 stripes close together, the outer pair—homologous with the dorso-lateral lines of *undulata*—thickest. Head orange-brown, brighter than that of *undulata;* all legs essentially concolourous with the ground. The anal legs have on their postero-lateral flank a roundish isolated slate-colored spot, quite large, in place of the produced dorso-lateral line as in *undulata*. There is also a dark anal plate. Cervical plate pale. The lateral and ventral pinacula are strongly pigmented and stand out as minute dots. In alcoholic specimens the slate color fades to brown and the ground color becomes pale yellow.

Pupa—Surprisingly, it is possible to distinguish the two species of *Calocalpe* on pupal characters. In *prunivorata*, the prongs of the forked cremaster are recurved, not straight, and the conical base bears only two pairs of hooks, not three.

Food plants—Wild cherry, perhaps only the one species, *Prunus serotina*.

Distribution—Nova Scotia south through New England and the Middle Atlantic States to North Carolina; westward through southern Quebec and Ontario, New York, Pennsylvania, Ohio to Illinois and Wisconsin. A single female in the American Museum of Natural History labelled Prescott, Ariz. is certainly this species by genitalia, but I suspect a mix-up in labelling.

Flight Period—May 14—Sept. 3. Two broods overlapping in the south; probably only one in the north. The earliest dates, all the ones in May, are from N.Y., Pa., N.J. and Ill. The September records are from Conn., N.Y. and Ohio.

Material examined—Specimens: 162; slides: male, 40; female, 9.

Acknowledgements

I am indebted to Dr. Frederick H. Rindge of the American Museum of Natural History, Dr. John G. Franclemont of Cornell, and to the authorities in charge of the Canadian National Collection at Ottawa for the loan of much of the material upon which this study was based.

Further Aphids of the Maritime Provinces (Homoptera: Aphidae)[1]

By M. E. MacGillivray[2]

Field Crop Insect Section, Entomology Laboratory, Fredericton, N.B.

MacGillivray (1952) listed aphids of the genus *Aphis* from the Maritime Provinces. Following are further records, from this region, of species of the tribes Aphini, including additional species of *Aphis*, Panaphini, and Lachnini. Slides of most of the material are at the Fredericton laboratory.

Tribe *Aphini* Gillette and Palmer

Subtribe *Aphina* Gillette and Palmer

Genus *Aphis* Linnaeus

coreopsidis Thomas.—Alate and apterous viviparous females were collected at Woodstock, N.B., August 7, 1950, from *Bidens* sp.

eriophori Walker.—Alate viviparous females were collected from July to October, 1953, and alate males in October, 1953, in an aphid trap at Point Escuminac, N.B.

fabae Scopoli.—This species was recorded by MacGillivray (1952) as *Aphis rumicis* Linnaeus. The writer is following the synonymy established by Palmer (1952).

spiraephila Patch.—Alate and apterous viviparous females were collected on *Spiraea* sp. at Tidehead, N.B., June 20, 1951; at Point Escuminac, N.B., July 11, 1951; and at Fredericton, N.B., during June and July, 1951 to 1953.

Genus *Brevicoryne* van der Goot

brassicae (Linnaeus).—This species was collected on *Brassica napobrassica* Mill., November 7, 1948. All specimens were apterous forms and were infesting the crowns of plants in a Science Service greenhouse at the Canada Experimental Station, Fredericton, N.B. Burnham (1938) recorded this species from *Hedera helix* L., samples being collected on April 29, 1936.

Genus *Cavariella* Del Guercio

aegopodii (Scopoli).—Alate and apterous viviparous females were collected from *Apium graveolens* L. at Fredericton, N.B., August 16, 1939, and at Charlottetown, P.E.I., August 28, 1943; from *Daucus carota* L. at Fredericton, N.B., August 5, 1950, and at Maugerville, N.B., August 9, 1950; from *Salix babylonica* L. at Maugerville, N.B., June 6, 1950; and from *Salix alba* L. at Fredericton, N.B., June 12, 1951, and May 4, 1953. Alate viviparous females were collected on *Pastinaca sativa* L. at Oromocto, N.B., June 4, 1952.

pastinacae (Linnaeus).—Alate and apterous viviparous females were collected on *Salix* sp. at Woodstock, N.B., July 25, 1950, and from *Daucus carota* L. at Maugerville, N.B., June 24, 1952. Burnham (1938) considered this species to be *Cavariella aegopodii* (Scopoli).

theobaldi (Gillette and Bragg).—Alate and apterous viviparous females were collected on *Salix* sp., June 11, 1951, and on *Salix alba* L., July 10, 1951, and June 2 and 17, 1952. Oviparous females were collected on *Salix alba* L., October 7, 1952. All collections were made at Fredericton, N.B. Burnham (1938) recorded this species from *Paeonia* sp., collected at Fredericton, N.B., June 30, 1936.

Genus *Hyadaphis* Kirkaldy

hyadaphis Kirkaldy.—Alate viviparous females were collected on *Lonicera* sp., June 9, 1949, and June 7, 1953. Apterous viviparous females were collected

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on *Sium suave* Walt., July 30, 1952, and on *Lonicera* sp., May 30, 1953, at Fredericton, N.B.

Genus *Hyalopterus* Koch

arundinis (Fabricius.)—Apterous viviparous females were collected on *Prunus* sp. at Loggieville, N.B., July 23, 1949, and at Fredericton N.B., June 23, 1952. Alate and apterous viviparous females were collected on *Prunus* sp. at Pokiok, N.B., August 1, 1953.

atriplicis (Linnaeus).—Alate and apterous viviparous females were collected on *Chenopodium album* L. at Cope Tormentine, N.B., August 4, 1949; at Richibucto Cape, N.B., July 27, 1949; at Woodstock, N.B., July 19, 1950, and August 20, 1952; at Fredericton, N.B., July 26, 1950, and August 14-20, 1952; and at Douglas, N.B., August 7, 1950. Alate and apterous viviparous females were collected from *Solanum tuberosum* L. at Fredericton, N.B., August 4, 1950, and July 27, 1953, and at Lower Lincoln, N.B., August 28, 1952; from *Acer negundo* L., July 18, 1951; from *Galeopsis* sp., August 21, 1952; and from *Lycopersicum esculentum* Mill., August 21, 1952.

Genus *Liosomaphis* Walker

berberidis (Kaltenbach).—This species was collected from *Berberis thunbergii* D.C. and *Berberis vulgaris* L. at Fredericton, N.B. Apterous viviparous females were collected on June 22 and September 26, 1949; April 24, June 10, July 29, September 6, and October 3, 1950; May 21, June 8, July 18, and September 17, 1952; and April 9 and June 2, 1953. Alate viviparous females were collected on October 18, 1949, October 3, 1950, and July 3, 1953. Oviparous females were collected on October 18, 1949, and November 6, 1952. Oviparous females were also collected on *Viola* sp. and *Myosotis* sp., November 6, 1952. Burnham (1938) recorded this species from *Berberis vulgaris* L. and *Daucus carota* L.

Genus *Longicaudus* van der Goot

trirhodus (Walker).—Alate viviparous females were collected on *Aquilegia* sp. at Fredericton, N.B., September 13, 1950; August 21, 1952; August 25, September 9 and 11, and October 9, 1953. Alate males were collected on October 9, 1953.

Genus *Rhopalosiphum* Koch

maidis (Fitch).—This species was recorded by MacGillivray (1952) as *Aphis maidis* Fitch.

prunifoliae (Fitch).—Alate and apterous viviparous females were collected on *Crataegus crus-galli* L. at Charlottetown, P.E.I., June 23, 1948, and on *Malus pumila* Mill. at Fredericton, N.B., October 20, 1949, and October 5, 1950.

pseudoavenae (Patch).—The identity of this species is questionable. Dr. F. C. Hottes, Grand Junction, Colorado, checked the specimens and suggested that *R. pseudoavenae* (Patch) may be the same as *R. padi* (Linnaeus). Alate and apterous viviparous females were collected at Fredericton on *Prunus virginiana* L., June 9, 1949, September 26, 1935, October 5, 1950, May 26, 1952, and September 27, 1951; at Perth, N.B. on *Prunus* sp., June 17, 1951; and at Newcastle, N.B., on *Prunus nigra* Ait., October 6, 1952. Alate males and oviparous females were collected on *Prunus padus L.* and *Prunus virginiana* L., October 18, 1951, at Fredericton, N.B.

pseudobrassicae (Davis).—Alate and apterous viviparous females were collected at Fredericton, N.B., on *Rosa* sp., October 21, 1949; on *Rhus* sp., October

4, 1950; on *Raphanus sativus* L., August 5, 1950; and on *Capsella bursa-pastoris* L. from June to September, 1952. Apterous viviparous females were collected on *Zizania aquatica* L. var. *angustifolia* Hitchc. at Jemseg, N.B., September 15, 1945.

rhois Monell.—Alate and apterous viviparous females were collected on *Rhus typhina* L. at Fredericton, N.B., September 7, 1950; July 18, 1951; August 31, 1951; and October 6, 1952. Apterous viviparous females were also collected on this host at Curries' Mountain, N.B., August 12, 1950.

rufomaculata (Wilson).—Alate viviparous females were collected on *Chrysanthemum* sp. at Fredericton, N.B., September 29, 1950. This species is commonly found on chrysanthemum in commercial greenhouses.

Genus *Toxoptera* Koch

graminum (Rondani).—Alate viviparous females were collected at Woodstock, N.B., August 5, 1949, at Point Escuminac, N.B., August 29, 1951, and at Alma, N.B., August 6, 1951, in aphid traps.

Tribe *Panaphini* Palmer
Subtribe *Chaitophorina* Baker
Genus *Chaitophorus* Koch

neglectus Hottes and Frison.—Alate and apterous viviparous females were collected from *Populus* sp., June 22, 1949, and from *Populus balsamifera* L., July 24, 1950, at Woodstock, N.B. Burnham (1938) recorded this species from *Populus* sp. at Florenceville, N.B., June 17, 1937.

populifoliae (Oestlund).—Alate and apterous viviparous females were collected on *Populus tremuloides* Michx. at Mann's Mountain, N.B., August 23, 1949; at Woodstock, N.B., June 24, 1949; and at Fredericton, N.B., August 4, 1950. Alate viviparous females were collected on *Populus balsamifera* L. at Woodstock, N.B., July 24, 1950, and on *Populus* sp., at Lincoln, N.B., July 9, 1952.

viminalis Monell.—Alate and apterous viviparous females were collected on *Salix* sp. at Lindsay, N.B., June 5, 1942. Apterous viviparous females were collected at Fredericton, N.B., on *Salix* sp., September 5, 1950, and on *Populus* sp., October 5, 1950. Alate viviparous females were collected on *Salix* sp. at Burtts' Corner, N.B., July 27, 1950, and at Westchester, N.S., July 16, 1953, and on *Acer rubrum* L. at Noonan, N.B., August 4, 1950. Oviparous females were collected on *Salix discolor* Muhl. at Fredericton, N.B., October 17, 1949. Burnham (1938) recorded this species from *Salix tristis* Ait., June 17, 1937 at Florenceville, N.B.

Genus *Neothomasia* Baker

populicola (Thomas).—Alate and apterous viviparous females were collected on *Populus tremuloides* Michx. at Fredericton, N.B., July 24 and August 1, 1950; at Burtts' Corner, N.B., July 27, 1950; at MacDonalds' Corner, N.B., August 1, 1950; and at Noonan, N.B., July 14, 1950. Oviparous females and alate males were collected on *Populus tremuloides* Mich. at St. Quentin, N.B., September 15, 1937. Alate and apterous viviparous females were collected on *Populus balsamifera* L. at Woodstock, N.B., July 27, 1950, and August 4, 1949; at Allandale, N.B., August 21, 1949; and at Fredericton, N.B., July 14, 1950; on *Populus deltoides* Marsh. at Woodstock, N.B., August 4, 1949; on *Populus candicans* Ait. at Jacquet River, N.B., August 25, 1937; and *Populus* sp. at Upper Kent, N.B., June 19, 1952, and at Fredericton, N.B., June 19, 1951. Burnham (1938) recorded this species from *Populus tremuloides* Michx., July 27, 1934.

Genus *Periphyllus* van der Hoeven

americanus Baker.—Alate viviparous females were collected on *Acer saccharinum* L. at Bridgewater, N.S., June 7, 1949, and on *Acer saccharum* Marsh, at Willowdale, N.S., June 29, 1947.

lyropictus (Kessler).—Apterous viviparous females were collected on *Acer platanoides* L. at Halifax, N.S., August 8, 1950. Burnham (1938) recorded this species at Fredericton, N.B., from *Acer* sp. August, 1936.

negundinis (Thomas).—Apterous viviparous females were collected on June 5, 6, and 22 and October 20, 1949; August 5, 1950; and September 24, 1952. Alate and apterous viviparous females were collected on September 27, 1948; September 26, 1949; June 13, September 7, and October 3, 1950; and June 20, 1952. All collections were made at Fredericton, N.B., on *Acer negundo* L.

testudinacea (Fernie).—Alate and apterous viviparous females were collected on *Acer rubrum* L. at Annapolis Royal, N.S., June 7, 1951, and at Halifax, N.S., May 29, 1951; on *Acer saccharinum* L. at Waverly, N.S., June 4, 1952, and at Wolfville, N.S., June 7, 1949; on *Acer* sp. at Waverly, N.S., June 1, 1951, and at Annapolis, N.S., June 7, 1951; and on *Rhamnus* sp. at Bridgewater, N.S., June 10, 1949.

Subtribe *Drepanosiphina* Baker

Genus *Drepanaphis* Del Guercio

acerifoliae (Thomas).—Alate viviparous females were collected from *Acer* sp. at Fredericton, N.B., on August 28 and September 11, 1950, June 8, 1951, and August 27, 1952; at Woodstock, N.B., August 7, 1950; at Mouth of Keswick and Noonan, N.B., August 4, 1950; and at Bridgewater, N.S., June 18, 1949. Oviparous females were collected from *Acer rubrum* L. at Fredericton, N.B., October 17, 1949.

monelli (Davis).—Alate viviparous females were collected at Fredericton, N.B., from *Acer saccharinum* L., June 27, 1949; from *Acer negundo* L., August 10 and September 1, 1950; and from *Acer* sp., September 11, 1950, June 8, 1951, and July 9, 1952. Alate viviparous females were collected at Stanley, N.B., August 31, 1950, from *Acer saccharinum*, *Acer* sp., and *Populus* sp.; at Woodstock, N.B., from *Acer* sp., August 22, 1949; and at Glassville, N.B., from *Acer saccharinum*. July 20, 1949.

Subtribe *Panaphina* Palmer

Genus *Calaphis* Walsh

alni Baker.—Alate and apterous viviparous females were collected at Keswick, N.B., August 2, 1950, from *Alnus rugosa* (Du Roi).

betulaecolens (Fitch).—Alate and apterous viviparous females were collected at Fredericton, N.B., from June to October, 1949 to 1953, and at Woodstock, N.B., July 16, 1949, and July 19, 1950, on *Betula lutea* Michx. and *Betula alba* L. Alate viviparous females were collected at Noonan, N.B., July 21, 1949, on *Betula lutea*, and at Fredericton on July 10, 1950, from *Carpinus caroliniana* Walt. and on July 16, 1953, from *Pteridium* sp. Burnham (1938) recorded this species from *Betula lutea*.

Genus *Cepegillettea* Granovsky

myricae Patch.—Alate viviparous females were collected at Fredericton, N.B., on July 8, 1952, and July 13, 1953, from *Solanum tuberosum* L.; on July 8, 1952, from *Comptonia* sp; and on July 6, 1952, from *Pteridium* sp.

Genus *Euceraphis* Walker

betulae (Koch).—Alate viviparous females were collected from *Betula alba* L. at Fredericton, N.B., June 16, 1949, June 27 and July 20, 1950, and July 18,

1951; at Noonan, N.B., July 28, 1949, and August 4, 1950; at Hogan Settlement, N.B., August 15, 1950; and at Hamptown, N.B., June 17, 1951; from *Pteridium* sp. at Woodstock, N.B., July 19, 1950; from *Alnus* sp. at Fredericton, July 10, 1952; and from *Delphinium* sp. at Charlottetown, P.E.I., June 28, 1937. Alate males were collected from *Spiraea* sp. at Fredericton, October 4, 1950. Burnham (1938) recorded this species from *Picea canadensis* (Mill.) B.S.P. and *Betula lutea* Michx.

deducta Baker.—Alate viviparous females were collected from *Betula* sp. at Fredericton, N.B., June 29, 1950 and 1951.

gillettei (Davidson).—Alate viviparous females were collected at Woodstock, N.B., from *Betula alba* L., July 16, 1949, and from *Rubus* sp., July 20, 1950; and at Fredericton, N.B., from *Prunus* sp., August 28, 1951. Alate males were collected at Fredericton from *Alnus incana* L., October 5, 1950.

Genus *Monellia* Oestlund

caryae (Monell).—Oviparous females and alate males were collected at Fredericton, N.B., from *Juglans nigra* L., September 10, 1948.

Genus *Myzocallis* Passerini

alnifoliae (Fitch).—Alate and apterous viviparous females were collected at Fredericton, N.B., from *Alnus glutinosa* (L.) Gaertn., August 21 and August 28, 1953, from *Alnus rugosa* (Du Roi) Spreng., August 10, 1950, from *Alnus* sp., June 18 and July 10, 1952, and from *Betula* sp., July 10 and 11, 1952; at Mouth of Keswick, N.B., from *Alnus rugosa*, August 3, 1950; and at Boiestown, N.B., from *Prunus* sp., June 13, 1951. Alate males and oviparous females were collected from *Alnus rugosa* at Fredericton, October 17, 1949.

bellus Walsh.—Alate and apterous viviparous females were collected at Fredericton, N.B., from *Quercus* sp., September 2 and 5, 1950, and July 8, 1953.

ononidis (Kaltenbach).—Alate viviparous females were collected at Fredericton, N.B., July 17, 1953, from *Trifolium* sp., and were observed in aphid traps at Escuminac, Woodstock, and Fredericton, N.B.

tiliae (Linnaeus).—Alate viviparous females were collected from *Tilia europea* L. at Reids' Station, N.S., June 12, 1951, and at Fredericton, N.B., June 29, 1951; and from *Tilia americana* L. at Summerside, P.E.I., July 17, 1941; at Weymouth, N.S., June 7, 1941; at Fredericton, N.B., August 10 and September 3, 1950, and August 21, 1953; and at Saint John, N.B., July 16, 1949. Alate males and oviparous females were collected at Fredericton, N.B., October 18, 1949, from *Tilia americana* L. Burnham (1938) recorded this species from *Tilia americana* L.

ulmifolii (Monell).—Apterous and alate viviparous females were collected at Fredericton, N.B., from *Ulmus americana* L., July 14 and 18, 1951; from *Ulmus* sp., June 29, 1949, August 14, September 7, and October 4, 1950, June 25, 1951, and August 31, 1953; from *Crataegus* sp., September 11, 1950; from *Dahlia* sp., September 6, 1950; and from *Zinnia* sp.

walshii (Monell).—Alate and apterous viviparous females of this species were collected from *Quercus* sp. at Grand Lake, N.B., July 12, 1952, and at Fredericton, N.B., September 7, 1952, and August 11, 1953.

Genus *Neosymydobius* Baker

annulatus (Koch).—Alate and apterous viviparous females were collected from *Lonicera* sp., June 11, 1953, and alate and apterous viviparous females and alate males from *Betula lutea* Michx., October 4, 1950, at Fredericton, N.B.

americanus (Baker).—Alate and apterous viviparous females were collected from *Betula* sp., at Eskasoni, Cape Breton, N.S., August 7, 1949.

Subtribe *Phyllaphina* Palmer
Genus *Phyllaphis* Koch

fagi (Linnaeus).—All collections of this species were from *Fagus* spp. Apterous viviparous females were collected at Fredericton, N.B., June 3 and 17 and September 11, 1950, and August 28, 1952; at Tay Falls, N.B., June 15, 1950; and at Yoho Lake, N.B., June 30, 1950. Alate viviparous females were collected at Earltown, N.S. July 8, 1950.

Subtribe *Pterocommina* Baker
Genus *Pterocomma* Buckton

bicolor (Oestlund).—Alate and apterous viviparous females were collected at Fredericton, N.B., from *Salix alba* L., June 17, 1952, and from *Salix babylonica* L,. August 18, 1950.

flocculosa (Weed).—Viviparous females bearing wing pads were collected from *Salix* sp. at Charlottetown P.E.I., June 16, 1937.

populea (Kaltenbach).—Alate and apterous viviparous females were collected at Corner Brook, Nfld., from *Populus balsamifera* L., July 10, 1953.

populifoliae (Fitch).—Alate and apterous viviparous females were collected from *Populus grandidentata* Michx. at Noonan, N.B., July 12 and 14, 1950. These specimens were checked against the type and determined by Miss L. M. Russell, United States Department of Agriculture, Washington, D.C. The species described under this name by Palmer (1952), is not the same. The third antennal segments of the apterous viviparous females of the New Brunswick specimens and the types bear sensoria.

smithiae (Monell).—Apterous viviparous females were collected from *Salix* sp. at Doaktown, N.B., August 28, 1950, from *Salix babylonica* L., at Fredericton, N.B., August 18, 1950, and from *Populus canadensis* Moench var. *eugenei* (Schelle) at Douglas, N.B., May 30, 1949. Apterous and alate viviparous females were collected from *Populus balsamifera* L. at Fredericton, N.B., May 6, 1949, and from *Populus tremuloides* Michx. at St. Stephen, N.B., June, 1952.

Species near *populifoliae* (Fitch).—Alate and apterous viviparous females of *Pterocomma* sp. were collected from *Populus balsamifera* L. at St. George, N.B., June 18, 1953. According to Miss Russell (in litt.) this may be the species discussed by Palmer (1952) under *P. populifoliae* (Fitch). The species is probably undescribed.

Tribe *Lachnini* Wilson
Subtribe *Cinarina* Borner
Genus *Cinara* Curtis

curvipes (Patch).—Apterous viviparous females were collected from *Abies balsamea* (L.) Mill. at Debec, N.S., August 20, 1951, and at Fredericton, N.B., August 28, 1952. Alate males were collected from *Abies balsamea* at Fredericton, August 28, 1952.

laricifex (Fitch).—Alate viviparous females were collected from *Larix laricina* (Du Roi) K. Koch at Fredericton, N.B., June 30, 1949. Apterous viviparous females were collected at Marion Bridge, N.S., July 2, 1950, and at Fredericton, N.B., May 6, 1949, from *Larix laricina.*

laricifoliae (Wilson).—All collections of this species were made from *Larix laricina* (Du Roi) K. Koch. Alate viviparous females were collected at Marion Bridge, N.S., July 2, 1950, and at Fredericton, N.B., June 19, 1951. Apterous viviparous females were collected at Fredericton, N.B., August 9, 1950, and July 11, 1951, and at Douglas, N.B., June 22, 1953.

lasiocarpae (Gillette and Palmer).—Apterous viviparous females were collected from *Abies balsamea* (L.) Mill. at Alex Bay, Nfld., July 4, 1950; at Bloomfield Ridge, N.B., June 11, 1950; at Quisbis, N.B., June 19, 1951; at Grand Manan, N.B., May 30, 1953; and at Salisbury, N.B., June 16, 1953.

pinea (Mordvilko).—Apterous viviparous females were collected from *Pinus sylvestris* L. at Hubbards, N.S., June 25, 1951, and at Fredericton, N.B., December 5, 1951; and from *Pinus banksiana* Lamb. at Grand Falls, Nfld., July 23, 1950. Alate viviparous females were collected from *Pinus sylvestris* L. at Fredericton, December 5, 1951.

strobi (Fitch).—Alate and apterous viviparous females were collected from *Pinus strobus* L. at Taxis River, N.B., June 13, 1952, at New Germany, N.S., and at Ogilvie Brook, N.S. June 27, 1951; from *Pinus resinosa* Ait. at Fredericton, N.B., June 24, 1949, and July 5, 1950; and from *Pinus banksiana* Lamb. at Elmsdale, N.B., June 23, 1953, and at Hubbards, N.S., June 25, 1951.

Subtribe *Eulachnina* Baker

Genus *Eulachnus* Del Guercio

agilis (Kaltenbach).—Burnham (1938) recorded this species from *Picea rubra* (Du Roi) Dietr.

Genus *Schizolachnus* Mordvilko

pini-radiatae (Davidson).—Alate and apterous viviparous females were collected from *Pinus resinosa* Ait. at Fredericton, N.B., October 20, 1949, July 26, and October 6, 1950; and at Blissville, N.B., July 13, 1953.

Subtribe *Tramina* Baker

Genus *Trama* Heyden

rara (Mordvilko).—Apterous viviparous females were collected at Fredericton, N.B., on the roots of *Hesperis* sp., August 13, 1953.

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References

Baker, A. C. 1917. Eastern aphids, new or little known. Part II. *J. Econ. Ent.* 10: 420-433.

Baker, A. C. 1920. Generic classification of the hemipterous family Aphididae. *United States Dept. Agr. Bull.* 826: 1-109.

Börner, C. 1952. Europae centralis Aphides. Die Blattlause Mitteleuropas. Schrift. Thuringischen Land. Heilpflanzenk. Weimar 4(2) (Mitt. Thüringischen bot. Gesel. Beih. 3(2)).

Burnham, J. C. 1938. A contribution to a list of the Aphididae of the Maritime Provinces of of Canada. *Canadian Ent.* 70: 180-183.

Essig, E. O. 1952. The aphid genus *Periphyllus* (Family Aphidae), a systematic, biological, and ecological study. Univ. California Press, Berkley and Los Angeles.

Hille Ris Lambers, D. 1934. Notes on Theobald's "The plant lice or Aphididae of Great Britain. II & III." *Stylops* 3: 25-33.

Hille Ris Lambers, D. 1947. On some mainly western European aphids. *Zool. Meded.* 28: 310.

Hottes, F. C., and T. H. Frison. 1931. The plant lice or Aphididae of Illinois. *Illinois Nat. Hist. Surv. Bull.* 19: 121-447.

MacGillivray, M. E. 1952. Some aphids of the genus *Aphis* from the Maritime Provinces of Canada. *Canadian Ent.* 84: 74-76.

Palmer, M. A. 1952. Aphids of the Rocky Mountain region. The Thomas Say Foundation. Vol. 5.

Patch, E. M. 1917. The aphids of choke cherry and grain. *Maine Agr. Expt. Sta. Bull.* 267: 293-297.

Theobald, F. V. 1927. The plant lice or Aphididae of Great Britain. 2. Headley Brothers, London.

Notes on Insects and Other Arthropods in Red and White Pine Logging Slash[1]

By J. B. THOMAS[2]

Introduction

Logging slash constitutes an environment supporting a particular association of insects and other arthropods. At first, the species in the community are governed by the character of the slash, but with the passage of time the condition of the slash changes, the rate of change being directly affected by bark beetles and other wood borers that facilitate entry of wood-destroying fungi. As the environment changes, those species for which the habitat is no longer suitable drop out, leaving in the association only those that can exist under the new conditions. Insect communities in slash, logs, and dying trees have been studied by Hopkins (1893, 1899), Clemens (1916), Blackman and Stage (1918, 1924), Graham (1925), DeLeon (1934), Beal and Massey (1945), Howden and Vogt (1951), and others. The succession of communities of animals inhabiting slash, logs, and dying and dead trees has been shown by Adams (1915) and Savely (1939) to continue until the wood has disintegrated completely.

In 1950, a study was made of the community of insects and other arthropods invading red and white pine logging slash during its first summer of exposure to attack. Cutting of red and white pine had been carried on during the winter months for a number of years previous to 1950, thereby providing a continuous supply of slash favouring the development of a large population of bark beetles and associated species. Cutting operations in 1949 did not start until the third week of October, which precluded the possibility of insects attacking the new slash until the spring of 1950.

The writer appreciates the advice of Dr. M. L. Prebble, Chief, Forest Biology Division, who suggested the study and offered valuable criticism during the field work and in the preparation of the original manuscript. Dr. R. M. Belyea and other associates at the Forest Insect Laboratory, Sault Ste. Marie, reviewed the final manuscript. Specialists in the Systematic Entomology Unit, Entomology Division, Ottawa, identified the insects. Dr. H. H. J. Nesbitt, Carleton College, Ottawa, identified the mites, and Dr. S. I. Auerbach, Northwestern University, Evanston, Illinois, the centipedes.

Forest Composition of the Study Area

The investigation was carried out at Lake Kipawa, near the Ontario-Quebec border, at 47 degrees north latitude and an elevation of approximately 884 feet above mean sea level. While the forest in the vicinity of Lake Kipawa is in the Algonquin-Laurentides section of the Great Lakes-St. Lawrence Forest Region of Halliday (1937), it is adjacent to the southern limits of the Boreal Forest Region, and this is reflected in the tree species represented. The forest is mixed coniferous, white pine, *Pinus strobus* L., and red pine *P. resinosa* Ait., being the dominant species. White spruce, *Picea glauca* (Moench) Voss, black spruce, *P. mariana* (Mill.) B.S.P., and balsam fir, *Abies balsamea* (L.) Mill., occur with the red and white pine, whereas jack pine, *Pinus banksiana* Lamb., occupies a number of burned-over tracts. White cedar, *Thuja occidentalis* L., yellow birch, *Betula lutea* Michx., and black ash, *Fraxinus nigra* Marsh., grow in low areas and swamps. Largetooth aspen, *Populus grandidentata* Michx., trembling

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aspen, *P. tremuloides* Michx., and white birch, *Betula papyrifera* Marsh., are mixed with red and white pine throughout the area and constitute a high percentage of the residual stand.

Methods

Twenty-five stumps and an equal number of tops of each of the species of pine were chosen for periodic examination and identified by metal tags. Every three or four days a small section of bark was removed from three stumps and from the lower end, centre, and branches of three tops of each species. Samples of all insect and other animal life found in the slash were preserved in 70 per cent alcohol or placed alive in cardboard boxes for further study. Pupae found under the bark and around the bases of the stumps were kept for emergence of the adults. Notes were made on predation or parasitism and on general feeding habits of as many species as possible. To supplement the latter observations on some species, further studies were made under laboratory conditions using a rearing device similar to that described by Kaston and Riggs (1937). Sections of bark, duplicating as closely as possible the condition of the material in which the insects were collected, were placed between two sheets of glass, four inches square. The insects were placed on the bark and the glass sheets held together by elastic bands. To prevent excessive drying of the bark and to keep the insects from escaping, absorbent cotton was packed around the edges of the bark between the two sheets of glass and kept moistened. Bark-beetle larvae and other insects were offered as food and their acceptance or rejection was observed.

Species Comprising the Community

Approximately 140 species of insects and other arthropods were collected from the 100 collection points in the study area. Only a lower limit to the total number of species present in the sample can be given because many of the larvae, particularly those in the order Diptera, could not be identified to species or, in many cases, even to genus. The bulk of the specimens were in the class Insecta with only a few in the classes Chilopoda and Arachnida. Most of the insects belonged to three orders, Coleoptera, Diptera, and Hymenoptera, and a few species were in Lepidoptera, Homoptera, Hemiptera, Psocoptera, and Collembola. Those species that occurred frequently enough to form a definite part of the community are enumerated below. These have been segregated into four groups based on observed or known feeding habits, and brief notes concerning their activities have been included. About the same number of species occurred in the stumps of each species of pine. Similarly, the number of species in the tops of the two pines were approximately equal although there were slightly fewer in the tops than in the stumps. The bark beetles attacked the slash first and with many species the population of immature forms reached a peak during the first half of the season. Shortly after the bark beetles, the slash was attacked by a group of borers and weevils of the families Cerambycidae, Buprestidae, Pythidae, and Curculionidae. With the possible exception of species of Pythidae, these borers were not dependent upon the bark beetles to gain entry under the bark. Insects in the second major group, that fed upon fungus, frass, and detritus under the bark, were dependent upon the prior activities of the group of primary bark beetles and borers which loosened the bark and provided a suitable environment. Species in this group were still present in late September of 1950 and might be expected to have formed an important part of the community in the following season. Parasites and predators, which constituted the third and fourth group of insects, were entirely dependent for food upon the presence of insects in the first two groups.

Group I — Phloem and Sapwood Borers

COLEOPTERA:

Scolytidae: *Dendroctonus valens* Lec.—Usually found in the lower parts of the stumps with egg galleries frequently extending several inches below ground level. *Dryocoetes americanus* Hopk.—Recovered from roots of red and white pine stumps in late July after most of the available space above ground had been occupied by other species. Associated with second broods of *Hylurgops pinifex* and *Orthotomicus caelatus*. A nitidulid, *Epuraea* sp., was frequently found in the galleries.

Gnathotrichus materiarius (Fitch), *Trypodendron bivittatum* (Kby.)—Both ambrosia beetles confined their attack to stumps where moisture conditions were most suitable for the propagation of their food. Larvae of a nitidulid, *Glischrochilus sanguinolentus*, and of a species of staphylinid were found in the tunnels but no cases of actual predation were observed.

Hylurgops pinifex (Fitch)—Associated with *Orthotomicus caelatus*, *Dendroctonus valens*, *Ips chagnoni*, and *I. pini* in the stumps. Immature stages were attacked by larval and adult staphylinids, histerids, and nitidulids. Small nitidulid beetles of the genus *Epuraea* were nearly always present in the galleries but were not predacious. Syrphid larvae were frequently found in many of the second-brood galleries.

Ips chagnoni Sw.—Found only in the stumps in association with *Orthotomicus caelatus*, *Hylurgops pinifex*, and *Dendroctonus valens*. Immature stages were attacked by nearly all species of predators in the stumps.

Ips pini (Say)—Occurred chiefly in the tops and occasionally in the stumps. In white pine tops, the rough, thick-barked areas near the lower end were preferred, the smooth, thin-barked regions farther up the main stem and in the branches being occupied by *Pityogenes hopkinsi*. A transition zone occurred between rough and smooth bark in which there was competition between the two species. As the number of attacks by *I. pini* increased, the adults were forced to use more unfavourable sites and to encroach upon territory formerly occupied solely by *P. hopkinsi*. In red pine, the former beetle occupied the main stem and large branches possibly because the rough, scaly bark over the entire surface afforded a secure position at many places for cutting entrance holes. This species was heavily attacked by predators and parasites.

Pityogenes hopkinsi Sw.—As described in the preceding paragraph.

Pityogenes plagiatus (Lec.)—Found in the small branches of red pine in association with *Ips pini* and *Pityogenes hopkinsi*.

Orthotomicus caelatus (Eich.)—Attacked the stumps only of pine and was one of the first bark beetles to attack. This may have been one of the reasons for the heavy predation by *Platysoma coarctatum*, *Platysoma* sp., *Thanasimus dubius*, *Enoclerus nigripes rufiventris*, *Nudobius cephalus*, *Quedius* spp., *Glischrochilus sanguinolentus*, and pseudoscorpions.

Cerambycidae: *Asemum atrum* Esch.—A shallow boring species found in the stumps of both species of pine.

Monochamus notatus (Drury) and *M. scutellatus* (Say)—The larvae, which are very similar in appearance, initially occupied the same feeding area in the phloem as larvae of *Ips pini* and *Pityogenes hopkinsi*, and later bored deeply into the wood. A tachinid fly, *Eutheresia trivittata*, attacked these borers.

Stenocorus inquisitor (L.)—Attacked the stumps early in the spring. The larvae were heavily parasitized by *Eutheresia nipigonensis* (Curr.), a large tachinid.

Pythidae: *Pytho americanus* Kby. and *Pytho* sp.—Larvae fed upon bark fibres and possibly on the boring dust in the galleries of bark beetles. They were not restricted to the galleries but could move freely wherever the bark had been slightly loosened. Associated with all species of bark beetles in the stumps and tops with the exception of the ambrosia beetles.

Curculionidae: *Pissodes* spp.—Two species of *Pissodes* were recovered from the stumps and tops. The larval borings in the stumps started close to the ground and in certain cases in the larger roots. Associated with *Dendroctonus valens*, *Hylurgops pinifex*, *Ips chagnoni*, and *Orthotomicus caelatus* in the stumps and *Ips pini* in the tops. A parasite, *Eubadizon* sp., was recovered from the chip cocoons in the stumps.

Buprestidae: *Buprestis maculativentris* Say, *B. nutalli* (Kby.), *B. striata* (Fab.) *Chalcophora virginiensis* (Drury), *Chrysobothris* sp., *Dicerca punctulata* (Schön.) and *D. tenebrosa* (Kby.)—Although adults of these species were very numerous about the slash, larvae were collected from the tops on two occasions only.

Group II — Fungus, Frass, and Detritus Feeders

COLLEMBOLA:

Entomobryidae: *Tomocerus* sp., unidentified sp.

Poduridae: unidentified sp.

Sminthuridae: *Sminthurus* sp.—Species belonging to all three families were collected under the bark, and although no direct observations of their feeding habits were made, they have been classed as commensals.

PSOCOPTERA:

Unidentified psocids were collected from the outer bark of the slash and later from beneath the loosened bark. Feeding habits were not determined.

COLEOPTERA:

Elateridae: *Agriotes fucosus* (Lec.) *Ampedus* sp., *Ctenicera triundulata* (Rand.), *Limonius aeger* Lec., *Melanotus* sp., and unidentified larvae—Adults of the species named were collected on and under the bark of stumps and also reared from pupae dug out of the humus at the base of the stumps. Unidentified elaterid larvae were found in the humus and under the bark, frequently in areas devoid of other insects. A few were predacious on larvae and pupae of *Hylurgops pinifex* and *Orthotomicus caelatus*.

Nitidulidae: *Epuraea* sp.—Found in the galleries of other insects as noted above. Feeding habits of the adults were not determined, but the larvae were observed feeding on fungi, boring dust, and other debris.

Rhizophagidae: *Rhizophagus* sp.—Adults only collected in the stumps from the galleries of *Hylurgops pinifex*, *Orthotomicus caelatus*, and *Ips pini*. As far as could be determined from field and laboratory observations, the adults were not predacious. They did not feed upon any larvae offered to them but chewed the decaying bark. Contrary to these findings, DeLeon (1934) found that both adults and larvae of *R. procerus* (Csy.) were predacious on the larvae and eggs of *Dendroctonus monticolae* Hopk.

Staphylinidae: *Atheta* sp. This species was very numerous in the galleries of *Ips pini* and *Pityogenes hopkinsi* and in the tunnels of *Monochamus* spp. Larvae and adults fed upon boring dust, fungi, and fragments of bark in the galleries. Fungus growing on dead pupae and adults of *I. pini* was eaten, but not the bodies of the insects.

DIPTERA:

Cecidomyiidae: *Aprionus* sp., *Holoneurus* sp., and unidentified larvae–Larvae, collected from the moist phloem, appeared to feed on the juices in the decaying bark.

Ceratopogonidae: *Forcipomyia texana simulata* Wal., *Forcipomyia* sp.–Larvae collected from under the bark of red pine tops, where they appeared to feed on the juices in the decaying bark.

Coenomyiidae: *Xylophagus fasciatus* Walk., and *Xylophagus* sp.–The larvae appeared late in the season after most of the bark beetles had emerged. No predation was observed although Clausen (1940), Curran (1934), and Peterson (1951) state that the larvae of this family are predacious on other insects.

Empidae: *Empis* sp.–Larvae were associated with *Dendroctonus valens*, *Hylurgops pinifex*, *Ips pini*, and *Pityogenes hopkinsi* but were frequently located where no insects were available for food. They appeared to be both scavengers and predators.

Lonchaeidae: *Lonchaea* sp., probably *watsoni* Curr.–Larvae were very numerous in the boring dust and other fragments of bark.

Phoridae: *Megaselia iroquoiana* Mall.–Numerous larvae found in the boring dust and bark debris. Larvae were scavengers feeding on dead larvae, pupae of various insects.

Sciaridae: *Plastosciara* sp.–Larvae and pupae found in compact masses under the bark of stumps. Larvae appeared to feed on decaying bark and possibly on fungi.
Scaptosciara myrmecophila Frey.–Large numbers of adults emerged from boring dust and bark debris collected from tops and stumps and kept in a rearing jar. No insect material was available to them for food.
Sciara sp.–Larvae found in masses on a thin web spun over small areas of the moist inner bark of tops and stumps.

Stratiomyiidae: *Neopachygaster maculicornis* (Hine), *Zabrachia polita* Coq., unidentified larvae–Larvae of *N. maculicornis* and unidentified sp. were collected from many of the galleries of *Ips pini*, *Hylurgops pinifex*, and *Dendroctonus valens*. Larvae of *Z. polita* were found in the stumps only. These larvae appeared to be both scavengers and predators.

Syrphidae: Genus near *Brachyopa*–Larvae collected from the galleries of *Hylurgops pinifex* and *Dendroctonus valens*. The larvae were coated with a mucous substance and were always found at the distal end of the egg galleries. It was not determined if they had been predacious on the beetles since, at the time of collecting, the beetles had disappeared. They appeared to be feeding on the plant juices, and may be both scavengers and predators.

Group III — Parasites

HYMENOPTERA:

Braconidae: *Aphaereta* sp.–Parasitic on a dipterous scavenger, *Megaselia iroquoiana*.
Coeloides sp.–From the pupal cells of *Ips pini*.
Eubadizon sp.–From chip cocoons of a weevil, *Pissodes* sp.

Pteromalidae: *Pachyceras eccoptogastri* Ratz.–Adults from the galleries of *Ips pini* and collected while they were ovipositing on tops infested by *I. pini*.
Rhopalicus pulchripennis (Cwfd.)–Cocoons from the pupal cells of *Ips pini*.
Rhopalicus tutela (Walk.)–Cocoons from the pupal cells of *Ips pini*.
Apparently only one other Canadian record of this species (personal communication, O. Peck, Systematic Entomology Unit, Ottawa).

DIPTERA:

Muscidae: *Phaonia harti* Mall.—Larvae and pupae from the pupal cells of *Stenocorus inquisitor.*

Tachinidae: *Eutheresia nipigonensis* (Curr.) ?, and *E. trivittata* Curr.—The first species was recovered from the pupal cells of *Stenocorus inquisitor* while *E. trivittata* was parasitic on the same borer and also on *Monochamus scutellatus.*

Group IV — Predators

CLASS CHILOPODA:

Nampabius n. sp., and *Geophilus* probably *rubens*—These centipedes were found on and under the bark after it had been loosened by bark beetles. They were probably facultative predators on bark beetles and other small animal life in the slash, occupying a permanent place in the forest floor fauna and migrating to the slash when opportunities for obtaining food were presented.

CLASS ARACHNIDA:

Pseudoscorpions were present in the galleries and are probably facultative predators of bark beetles. Mites were found soon after the bark beetle galleries were started and soon were found elsewhere under the bark. They adhered to the bodies of the adult bark beetles and were transported in this manner from one tree to another. It was not discovered if they were predacious on the adult beetles or merely used them as a means of transportation. Species belonging to three genera were collected from galleries in the bark and from the bodies of the bark beetles.

CLASS INSECTA

COLEOPTERA:

Cleridae: *Enoclerus nigripes rufiventris* Spin., and *Thanasimus dubius* (Fab.)—Adults of these species were active predators of adult bark beetles. The larvae fed on larvae of most species of bark beetles available and probably on larvae of associated insects. The adult clerids were in turn preyed upon by an ant, *Camponotus herculeanus.*

Elateridae: In certain instances elaterid larvae were predacious on larvae of bark beetles and other insects.

Histeridae: *Platysoma coarctatum* Lec., and *Platysoma* sp.—Predacious on all stages of bark beetles, the adults entering the galleries shortly after they were started.

Nitidulidae: *Glischrochilus sanguinolentus* (Oliv.)—Larvae and adults were predacious and were recovered from the galleries of all species of bark beetles breeding in the stumps.

Staphylinidae: *Nudobius cephalus* (Say)—Probably predacious on most bark beetles. Observed feeding on an adult bark beetle, *Orthotomicus caelatus.*

Quedius spp.—Species of this genus were found under the bark in association with bark beetles and other insects.

Tenebrionidae: *Corticeus* sp.—Adults and larvae were collected from the galleries of *Ips pini, Hylurgops pinifex, Orthotomicus caelatus,* and elsewhere under the bark. Larvae were predacious on the immature stages of bark beetles and also were cannibalistic.

HYMENOPTERA:

Formicidae: *Camponotus herculeanus* (L.)—These large ants were predacious on immature stages of bark beetles and on other associated insects.

References

Adams, C. C. 1915. An ecological study of prairie and forest invertebrates. *Bull. Ill. State. Lab. Nat. Hist.* 11: 30-280.

Beal, J. A. and C. L. Massey. 1945. Bark beetles and ambrosia beetles (Coleoptera: Scolytoidea) with special reference to species occurring in North Carolina, 178 pp., *Duke University, School of Forestry, Bull.* 10.

Blackman, M. W. and H. H. Stage. 1918. Notes on insects bred from the bark and wood of the American larch, *Larix laricina* (DuRoi) K. Koch., *N.Y. State Coll. of Forestry Tech. Pub.* 10: 11-115.

Blackman, M. W. and H. H. Stage. 1924. On the succession of insects living in the bark and wood of dying, dead and decaying hickory, *N.Y. State Coll. of Forestry Tech. Pub.* 17: 3-272.

Clausen, C. P. 1940. Entomophagous insects, 688 pp., *McGraw-Hill Book Co. Inc. New York and London.*

Clemens, W. A. 1916. The pine bark beetle, *Cor. Univ. Agr. Exp. Sta. Bull.* 383: 287-298.

Curran, C. H. 1934. The families and genera of North American Diptera, 512 pp., *The Ballou Press, New York.*

DeLeon, D. 1934. An annotated list of the parasites, predators and other associated fauna of the mountain pine beetle in western pine and lodgepole pine. *Can. Ent.* 66 (3): 51-66.

Graham, S. A. 1925. The felled tree trunk as an ecological unit. *Ecol.* 6 (4): 397-411.

Halliday, W. E. D. 1937. A forest classification for Canada, 50 pp., *Canada Dept. of Resources and Development, Forestry Branch, For. Res. Div. Bull.* 89.

Hopkins, A. D. 1893. Catalogue of West Virginia Scolytidae and their enemies. *W. Va. Agr. Exp. Sta. Bull.* 31: 121-168.

Hopkins, A. D. 1899. Report on investigations to determine the cause of unhealthy conditions of spruce and pine from 1880-1893. *W. Va. Agr. Exp. Sta. Bull.* 56: 197-461.

Howden, H. F. and G. B. Vogt. 1951. Insect communities of standing dead pine (*Pinus virginiana* Mill.), *Ann. Ent. Soc. Amer.* 44 (4): 581-595.

Kaston, B. J. and D. S. Riggs. 1937. Studies on the larvae of the native elm bark beetle. *J. Econ. Ent.* 30(1): 98-108.

Peterson, A. 1951. Larvae of insects, Part II. 416 pp., *Lithoprinted, Edwards Brothers Inc. Ann Arbor, Michigan.*

Savely, H. E. Jr. 1939. Ecological relations of certain animals in dead pine and oak logs. *Ecol. Monog.* 9(3): 323-385.

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A New Method For Handling Insect Eggs[1]

By R. H. Backs[2]

Occasions frequently arise in entomological work when it is necessary to handle large numbers of insect eggs. If the eggs are to be counted or treated, it is often necessary that they be held in a fixed position. A technique has been devised at the Ottawa laboratory by which many eggs can be handled and held with great ease. The eggs to be treated are placed on a sheet of Saran Wrap (Dow Chemical Company, Midland, Mich.). The static charge on the plastic is strong enough to hold the eggs securely. After treatment the eggs can be removed by means of a moist brush. This method is ideal for topical application studies and, if the Saran Wrap is backed with aluminum foil, it may be used to make excellent micro weighing dishes with adhesive qualities.

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Identity of the Black Fly That Attacks Ducklings and Goslings in Canada (Diptera: Simuliidae)[1]

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For many years, the black fly *Simulium venustum* Say has been considered to be the chief vector of *Leucocytozoon simondi* M. & L. (=*L. anatis* Wick.), a protozoan parasite infesting the bloodstream of ducks and geese and causing a malarialike disease that is usually fatal to immature birds. The organism undergoes part of its life-cycle in the stomach of the fly, which transmits it, through its bite, to the primary host. Its development in the latter results in the rupture of blood cells, with extensive destruction of tissue of the spleen, liver, and other organs. Although, superficially, the case against *S. venustum* appears to be already proved, recent studies of this species in Eastern Canada have indicated that some aspects of its supposed relation to *L. simondi* cannot readily be explained on the basis of what is known of its life-history and habits. My attention was focussed on this problem when I discovered in 1953 that the *Simulium* species reported by Walker (1927) as causing wholesale deaths in a flock of goslings at Fredericton, N.B., was neither *Simulium bracteatum* Coq. (a synonym of *S.* (*Eusimulium*) *aureum* Fries), as reported by Walker, nor *S. venustum* Say, as suggested by Twinn (1933).

Ten female specimens from Walker's original material are in the Canadian National Collection. They belong to the species *Simulium rugglesi* Nicholson & Mickel (1950), which was described from specimens taken *on geese* in Todd County, Minnesota. This species resembles *venustum* closely in colour, but is noticeably smaller and has strongly toothed claws as in females of *Eusimulium* Roub. In this and other respects it is related to *Simulium slossonae* D. & S., a species that attacks turkeys as reported by Underhill (1939, 1944). In 1954, more evidence was obtained, from Fredericton and elsewhere, tending to confirm the importance of *rugglesi* as a pest of ducklings.

Evidence against *Simulium rugglesi*

On July 8, 29 specimens of *rugglesi*, taken while swarming around ducklings in a brooder house at the Northeastern Wildlife Station at the University of New Brunswick, were received from the Field Crop Insect Section, Entomology Laboratory, Fredericton.

On July 16, a number of collections of black flies, the result of a survey made at my request in the Fredericton area, were received from Mr. W. A. Reeks, Forest Biology Laboratory, Fredericton. Among these were 162 specimens of *rugglesi* taken on June 29 and 30 at Oromocto. Of these, 52 engorged specimens were taken from the bodies of ducklings and the rest were netted while hovering over the birds. Among the latter was also a single female specimen of *Simulium jenningsi* Mall. A distinction was purposely made between biting and hovering specimens because, unless they are taken in the act of biting, there is necessarily a doubt whether the flies are being attracted by the investigator or the bird. It was felt that, in the case of hovering specimens, a decided preponderance of one species would have to be demonstrated in order to indicate clearly that the preference was for the avian host. Between June 17 and July 9, Mr. Reeks also made four collections of black flies taken while biting

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or hovering around man. These consisted of 316 specimens of *S. venustum* and 49 of *Prosimulium hirtipes* (Fries).

On July 9, an engorged female of *rugglesi* was taken on the window of a poultry shed near Manotick, Ont., on the outskirts of Ottawa. The shed was on the property of my colleague Dr. T. N. Freeman, who suspected the presence of *Leucocytozoon* disease, having at that time already lost 20 ducklings out of a flock of 45 hatched on June 20. The affected ducklings had had access to the shed on the previous day. However, no black flies were detected swarming around full-grown ducks and geese in the run where the shed was situated and none were taken by sweeping surrounding bushes and undergrowth. A search for immature stages of *rugglesi* in the Rideau River and other streams near the property was unproductive. Although *rugglesi* has not previously been recorded in Ontario, *Leucocytozoon* disease has long been known to occur in the province, Wickware (1915) having described the parasite (as *Leucocytozoon anatis* n. sp.) after study of an outbreak among ducks in the Ottawa district.

Evidence against *Simulium venustum*

The acceptance of *S. venustum* as a vector of *L. simondi* is due almost entirely to the work of O'Roke (1930, 1931, 1934), who studied the incidence, pathology, and parasitology of the disease for four years in northern Michigan. In his 1934 paper summarizing this work, he states that *venustum* is the "one and only one probable transmitting host" and remarks that it was not unusual to remove "upward of 75 blood-gorged black flies from a single duckling at one time". He gives no information, however, as to the parts of the body most frequented by the flies. Fallis *et al.* (1951), in their study of the developmental cycle of the parasite within the black fly, did not procure specimens of *venustum* from natural infestations on ducklings, but used specimens netted around humans or captured in cage traps in streams and subsequently induced to feed in tubes attached to the bodies of the birds. There was evidently some difficulty in this method and the impression is given that the flies were not entirely willing collaborators. Further, although they were able to demonstrate development of the parasite to the infective stage in both *venustum* and *Simulium parnassum* Mall., they were unable to reconcile their findings with those of O'Roke as to the form of the oocyst stage and its location within the digestive tract of the host.

In considering the likelihood of *venustum* being involved in the spread of *L. simondi*, several conflicting facts are apparent. First, there is the negative evidence afforded by, for instance, the collections made near Fredericton. These indicate clearly that *venustum* was plentiful and biting humans freely during the time that the collections from the ducklings were made. If this species were really addicted to avian blood, its presence with *rugglesi* on the bodies of the birds could reasonably have been expected. Although it is true, as has been pointed out by Underhill (1939, 1940), that the biting behaviour of black flies is associated with climatic and probably other factors and that a species will appear suddenly and bite voraciously under certain conditions, but at other times, will be content to hover near the host and bite only occasionally or not at all, yet it seems to me that if *venustum* is to be accepted as an important pest of ducks some evidence corroborating O'Roke's findings, now 20 years old, must soon be produced. It is also remarkable that, with such a common and widespread species, there should be, in collections, so little evidence of its association with birds. Of several hundred specimens of *venustum* in the Cana-

dian National Collection, none bears a label indicating a connection with any kind of bird, and, apart from O'Roke's publications, I can cite no case from the literature.

Outbreaks of *L. simondi*

Another difficulty in accepting *venustum* as a vector of *L. simondi* arises from the point strongly made by O'Roke (1934) as to the seasonal prevalence of the disease. He asserts (p. 36), "All of the serious natural outbreaks have occurred in young ducks from ten days to four weeks old in the hottest part of the month of July, and simultaneously with the appearance of large numbers of black flies. It has also been observed that if ducklings hatch earlier and have grown to considerable size before the appearance of swarms of black flies, the losses . . . are not so severe".[1] Chernin and Sadun (1949), working in the same area as O'Roke, were able to verify his observations. They examined 43 ducklings between June 23 and 30 without finding any infection, but on July 10 found that four birds in a flock of seven were heavily parasitized. When the birds that were examined in June with negative results were reexamined in August, they were 100 per cent infected. Fallis *et al.* (p. 307), on the contrary, found natural infections to be equally heavy in June and July in Algonquin Park, Ont. With this exception, the evidence suggests that the main vector of the disease is a species that appears in the latter half of June and reaches a peak of abundance in the first or second week in July. The seasonal prevalence of *venustum*, however, at latitudes approximating that of northern Michigan, does not conform to this pattern.

Seasonal Abundance of *S. venustum*

In the Ottawa district, *venustum* begins to emerge in the middle of May. By the end of the month, it is combined about equally with *P. hirtipes* in biting swarms, the latter species being then somewhat past its greatest abundance. The *venustum* peak normally occurs in the second or third week in June and by the end of the first week of July there is a considerable falling off in abundance, perhaps associated with the drying up of many suitable breeding sites as the season advances.

Data from casual collections (which, in the case of such an abundant pest, are usually made as samples of biting swarms) tend to support this pattern. For example, Nicholson and Mickel report that, in the northern half of Minnesota, 12 collections were made in May, 10 in June, 3 in July, 2 in August, and 2 in September and October. A similar analysis, which I have made, of specimens in the Canadian National Collection taken in eastern Ontario shows 15 collections in May, 20 in June, 6 in July, nil in August, and 1 in September. Davies' (1950) studies of *venustum* in Algonquin Park from 1938 to 1943 show the same developmental pattern. He found that 90 per cent of females emerged over an average period of 36 days, the mid-point of emergence varying between May 25 and June 13. My own work during the past six years in the Ottawa district and at Knowlton, Que., in which collections from cage traps, of the type used by Davies, have been analysed, has given similar results. Therefore it is clear that, normally, *venustum* is plentiful in late May, is most abundant in June, and although still abundant, is in decline at the beginning of July. Because of this,

[1]In northern Michigan, according to records of the last 20 years in "Weekly Weather and Crop Bulletin", published by the U.S. Weather Bureau, the highest mean weekly July temperatures occur during the second half of the month, the hottest week being the third week. However, O'Roke may have intended the phrase *the hottest part of July* to refer to a two-week period in the middle of the month. In discussing control measures (p. 28), he refers to July 14, 1932, as being at the height of the *Leucocytozoon* epizootic.

it is difficult to understand why, if *venustum* is the chief vector of the disease, ducklings hatched at any time from mid May onwards are not as susceptible to *Leucocytozoon* infection as those that hatch in the latter half of June. On the other hand, if *Simulium rugglesi* is the main vector, this aspect of the problem is understandable because all data on the occurrence of this species suggests that it does not emerge until the third or fourth week of June at the latitude under consideration.

General Observations

In conclusion, some general observations seem pertinent to this problem. The feeding habits of *rugglesi* as described by Walker and verified by Mr. Reeks (personal communication) are different from those of *jenningsi* Mall. on turkeys as described by Underhill (1939). The latter species attaches itself to the head of the bird whereas *rugglesi* feeds beneath the feathers of the breast and abdomen. Mr. Reeks states that engorged flies do not at once leave the host but tend to remain hidden at the bases of the feathers, most of them being found around the legs, under the wings, and in the neck region. A common method of attack seems to be by crawling up the legs. The shape of the tarsal claw of *rugglesi* is interesting in this connection. Its resemblance to that found in typical species of *Eusimulium* (*aureum* Fries, *latipes* Mg., etc.) has already been mentioned and there is also a fundamental similarity in the shapes of this type of claw and that found throughout the Hippoboscidae. The hippoboscid claw, although much larger, has the same strong curvature and a similar long, broad, basal projection or tooth, with consequent deep narrow cleft between it and the main claw. It is difficult to avoid the conclusion that this is an adaptation concerned with ease of movement beneath feathers, either by providing a pincerlike grip enabling the fly to force its way through the plumage or perhaps, conversely, to prevent the claw from becoming inextricably entangled therein.

Examination of the biting records of New World species of Simuliidae shows that there are few records for species with claws of the hippoboscid type in comparison with those for species having simple or minutely toothed claws. This suggests that species in the first category either do not suck blood or that their biting habits are not easily observed because they frequent wild hosts or for some other reason. The overwhelming majority of species with simple or minutely toothed claws attack mammals, whereas, of the 10 species with hippoboscidlike claws for which biting records are available, no fewer than seven attack birds. On the other hand, instances can be cited of a species with simple claws attacking birds (*jenningsi* Mall.) and of a species with strongly toothed claws attacking mammals (*Cnephia pecuarum* (Riley)). Of these it must be remarked, however, that *jenningsi* attacks the featherless head region of turkeys (as already mentioned) and that *pecuarum* is well known as a pest of poultry as well as of livestock. There is therefore some evidence of a relation between the type of claw and the type of animal attacked. Rubsov (1940), discussing the comparative values of diagnostic characters of Simuliidae, places the shape of the claws first in order of diagnostic significance and states that claws with strong basal teeth (e.g., *S. latipes* Mg.) and simple claws (e.g., *S. reptans* (L) and *S. equinum* (L.)) are both archaic forms, whereas claws having small teeth at the base are of more recent origin. He offers, in support of this contention, the observation that the first two types of claws are clearly formed very early in the pupal stage.

Simulium rugglesi, although widely distributed, is rare in collections. In addition to the records already cited, a few specimens are on hand from Kaza-

bazua, Baie Comeau, and Rupert House, Que., and from Goose Bay, Labrador. I have also seen two specimens in the British Museum (Nat. Hist.) from St. Martins Falls, Albany R., Ont. The early stages have not been reported in Eastern Canada and the type of stream preferred by the larva is unknown. The closely related species *S. slossonae* D. & S. is found in rather sluggish water, according to Underhill (1944), and the same may be true of *rugglesi*. Such a condition would tend to occur towards midsummer and might account for the fly's comparatively late appearance. It might also impose on the species an uneven or very variable population density throughout its range. Such a characteristic, as compared with the consistent abundance of *venustum*, would better account for the apparently sporadic and unpredictable nature of *Leucocytozoon* epizootics.

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References

Chernin, E., and E. H. Sadun. 1949. *Leucocytozoon simondi* infections in domestic ducks in northern Michigan with a note on *Haemoproteus*. *Poultry Sci.* 28: 890-893.

Davies, D. M. 1950. A study of the black fly population in a stream in Algonquin Park, Ontario. *Trans. Roy. Canadian Inst.* 28: 121-160.

Fallis, A. M., D. M. Davies, and M. A. Vickers. 1951. Life history of *Leucocytozoon simondi* Mathis and Leger in natural and experimental infections and blood changes produced in the avian host. *Canadian J. Zool.* 29: 305-328.

Nicholson, H. P., and C. E. Mickel. 1950. The black flies of Minnesota (Simuliidae). *Univ. Minnesota Agr. Expt. Sta. Tech. Bull.* 192.

O'Roke, E. C. 1930. The incidence, pathogenicity and transmission of *Leucocytozoon anatis* of ducks. *J. Parasit.* 17: 112.

O'Roke, E. C. 1931. The life history of *Leucocytozoon anatis* Wickware. *J. Parasit.* 18: 127.

O'Roke, E. C. 1934. A malaria-like disease of ducks caused by *Leucocytozoon anatis* Wickware. *Univ. Michigan School For. and Conser. Bull.* 4.

Rubsov, I. A. 1940. Simuliidae. Fauna of U.S.R.R. Insects. Dipt. 6 (6) (Carlo Zeimet translation).

Twinn, C. R. 1933. The black fly, *Simulium venustum* Say, and a protozoon disease of ducks. *Canadian Ent.* 65: 1-3.

Underhill, G. W. 1939. Two simuliids found feeding on turkeys in Virginia. *J. Econ. Ent.* 32: 765-768.

Underhill, G. W. 1940. Some factors influencing feeding activity of simuliids in the field. *J. Econ. Ent.* 33: 915-917.

Underhill, G. W. 1944. Black flies found feeding on turkeys in Virginia, (*Simulium nigroparvum* Twinn and *Simulium slossonae* Dyar and Shannon). *Virginia Agr. Expt. Sta. Tech. Bull.* 94.

Walker, G. P. 1927. A black fly, (*Simulium bracteatum*), fatal to goslings. *Canadian Ent.* 59: 123.

Wickware, A. B. 1915. Is *Leucocytozoon anatis* the cause of a new disease in ducks? *Parasitology* 8: 17-21.

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A Study of Predators of Mosquito Larvae and Pupae with a Radio-active Tracer[1]

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The importance of predators in the natural control of mosquitoes has been suggested by a number of workers. Comprehensive reviews have been presented by Hinman (1934) and Gerberich (1946). The conclusions are open to some question, however, since the investigations were confined for the most part to studies in laboratory aquaria. These environments create conditions such as crowding, absence of prey shelter, and lack of alternative prey, which prevent an analysis of predation in terms of field conditions. An accurate assessment of predation in nature requires a technique to identify predators that have consumed prey. This is a report on an attempt to analyse the predator-prey relationships of animals in a natural mosquito pool in a woodland swamp near Chatterton, in Hastings County, Ontario, in April and May, 1953, by means of a radio-active tracer.

Methods

Laboratory experiments were conducted in 1952 to determine whether predators would become radio-active after feeding on radio-active mosquito larvae. Mosquito larvae held for 24 hours in distilled water containing P^{32} at a concentration of 0.05 microcuries per milliliter (μc./ml.) were fed to individual predators. The average radio-activity of the mosquito larvae was 480 counts per minute (cpm.). The radio-activity of single specimens of the predators 24 hours after feeding was as follows:—

Predator	No. of Larvae Consumed	Radio-activity of Predator, cpm.
Limnephilus indivisus Wlk. (larva)	1	120
Limnephilus indivisus Wlk. (larva)	2	400
Limnephilus indivisus Wlk. (larva)	4	400
Ephemeridae (nymph)	1	75
Ephemeridae (nymph)	2	105
Callicorixa audeni Hung. (adult)	1	85
Callicorixa audeni Hung. (adult)	3	200
Hydrophilus obtusatus Say (larva)	3	200
Ranatra fusca Beauv.	10	1300

For field experiments, four bays of a large permanent pool in the swamp were walled off, making ponds with similar fauna. Tests were completed on April 14 and 22 and May 5 and 11, 1953, during the development of the mosquitoes, one pond being studied on each date (Table II). The ponds contained mixed populations of *Aedes stimulans* (Wlk.) and *A. trichurus* (Dyar) in the ratio of approximately two to one.

The densities of mosquito larvae and predators were estimated in each pond, the mosquito densities by releasing known numbers of tagged individuals and resampling and the predator densities by dividing the number of radio-active animals in the pond by its area. As many as possible of the macroscopic animals were collected on the day after the tagged mosquitoes were released and then

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tested for radio-activity, the animals being tentatively named when collected. The approximate areas of the ponds were calculated by the use of a co-ordinate system and Simpson's one-third rule for areas of irregular shape.

Larvae were rendered radio-active by removing as many as possible from each pond and placing them in flat, five-gallon trays containing pond water with $H_3P^{32}O_4$ at a concentration of 0.05 μc./ml., the larval density in the trays being maintained at approximately 200 larvae per litre (Baldwin, Welch, and Riordan, in preparation). After 24 hours the larvae were removed from the radio-active water and washed twice in fresh pond water. The larvae were left for two more days in fresh pond water to rid themselves of radio-active excreta; where this step was omitted in preliminary experiments, the ponds became contaminated and all animals became radio-active. After this two-day period a small number of larvae were taken for radiation determinations and the remainder were returned to the ponds. In the test of May 11, the larvae were held for release until they became pupae.

All radio-active counts were made with a Tracerlab (Tracerlab, Inc., Boston, Mass.) survey meter fitted with an end-window Geiger tube. Each animal was placed on a square piece of damp blotting paper (2 x 2 cm.) on aluminium planchettes for radiation counts. Background radiation was subtracted from all results given in this paper.

Results and Discussion

The results of the experiments are presented in Table I. In Pond I, *Limnephilus* sp. and dytiscid adults were found to be radio-active and were therefore predators of larvae. In Pond II, an additional five species were found to be predacious, namely, *Stagnicola palustris* (Müller), *Gerris* sp., *Limnephilus indivisus* Wlk., *Gyrinus lecontei* Fall, and *Hydrophilus obtusatus* Say. The results from Pond III showed that dytiscid larvae were also predacious. In Pond IV, the following predators of pupae were found: *Glossiphonia fusca* Castle, *S. palustris, Belostoma fluminea* Say, *Limnephilus* sp., *L. indivisus*, Dytiscidae (larvae and adults), *H. obtusatus*, and *Tabanus* sp.

The importance of the various predator species in control was indicated by their radio-activity and numbers. The predators of which the greatest numbers fed on radio-active mosquitoes were limnephilids and dytiscids; in Pond IV, 369 of 371 limnephilids, and in all four ponds a large portion of the dytiscid larvae and adults became radio-active. The greater abundance of limnephilids in the ponds, however, would result in a higher degree of control by these animals. Another important record is the number of radio-active pond-snails. It was not uncommon to observe *S. palustris* feeding on mosquito larvae and pupae in the ponds.

The average and range of the radio-activity of each predator species (Table I) give indications of the numbers of radio-active mosquitoes consumed by individual specimens. The greater radio-activity of some predators suggests that they had consumed more radio-active prey, although the wide range of radio-activity found in the prey and the fact that some predators consume only a part of the prey would prevent any accurate assessment of predation by this means. Dytiscid adults and larvae consumed many radio-active mosquitoes, the average counts per minute of dytiscid larvae and adults in Pond IV being 1070 and 640, the highest found in all the experiments. The dytiscids are followed by hydrophilids and caddisflies, *L. indivisus* being the more important of the two caddisflies. Further, the average radio-activity recorded for each predator

TABLE I

Numbers of animals taken from woodland ponds, and radio-activity of those that had fed on radio-active mosquitoes, Chatterton, Ont., 1953[1]

Animal taken from pond	Pond I (April 14)				Pond II (April 22)				Pond III (May 5)				Pond IV (May 11)			
	Total number	Number radio-active	Average cpm.	Range cpm.	Total number	Number radio-active	Average cpm.	Range cpm.	Total number	Number radio-active	Average cpm.	Range cpm.	Total number	Number radio-active	Average cpm.	Range cpm.
HIRUDINEA																
Hirudinea	0	–	–	–	0	–	–	–	0	–	–	–	1	1	20	–
GASTROPODA																
Stagnicola palustris (Müller)	3	0	–	–	21	1	25	–	32	10	22	10–30	6	5	53	16–140
Planorbula armigera (Say)	1	0	–	–	0	–	–	–	2	0	–	–	0	–	–	–
CRUSTACEA																
Eucrangonyx sp.	7	0	–	–	2	0	–	–	7	0	–	–	20	0	–	–
INSECTA																
Ephemerida (nymph)	1	0	–	–	0	–	–	–	0	–	–	–	0	–	–	–
Belostoma fluminea Say	0	–	–	–	0	–	–	–	1	0	–	–	1	1	220	–
Callicorixa audeni Hung.	1	0	–	–	1	0	–	–	0	–	–	–	1	0	–	–
Gerris sp.	1	0	–	–	1	1	30	–	2	0	–	–	0	–	–	–
Limnephilus sp.	1	1	30	–	5	0	–	–	7	2	30	15–45	1	1	28	–
Limnephilus indivisus Wlk.	3	0	–	–	8	1	40	–	125	40	75	5–565	371	369	301[2]	10–3760
Dytiscidae (larvae)	0	–	–	–	0	–	–	–	5	5	59	40–115	11	10	1070	40–2760
Dytiscidae (adults)	6	5	61	23–215	13	8	230	30–565	16	12	105	29–190	12	10	640	15–2560
Gyrinus lecontei Fall.	0	–	–	–	1	1	40	–	0	–	–	–	1	0	–	–
Hydrophilus obtusatus Say	8	0	–	–	9	2	50	45–55	15	4	99	25–165	3	1	32	–
Hydrobius fuscipes L.	0	–	–	–	0	–	–	–	11	0	–	–	0	–	–	–
Mochlonyx culiciformis (Deg.)	0	–	–	–	12	0	–	–	19	0	–	–	20	0	–	–
Tabanus sp.	0	–	–	–	0	–	–	–	0	–	–	–	1	1	12	–
Totals	32	6			73	14			242	73			449	399		

1. Average and range of radio-activity of mosquitoes (Ponds I-III, larvae; Pond IV, pupae) released: Pond I, 98(50-410) cpm.; Pond II, 244(150-450) cpm.; Pond III, 2840(145-5000) cpm.; Pond IV, 218 (10-1265) cpm.
2. Average radio-activity of a sample of 48 specimens.

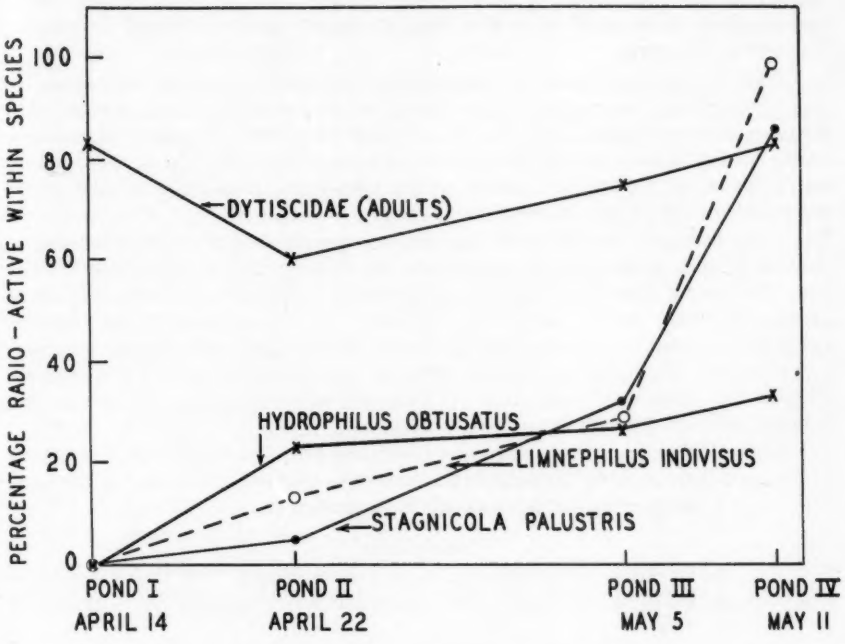

Fig. 1. Percentages of individuals of four types of predators that become radio-active in the four experiments.

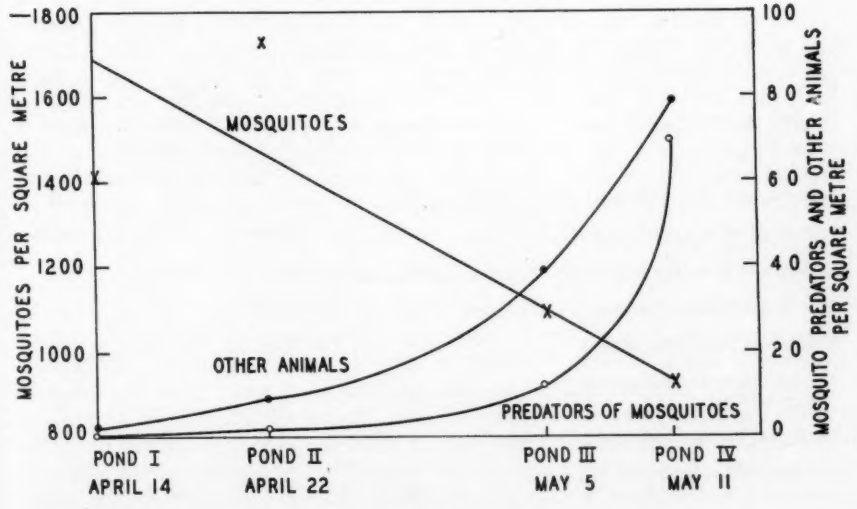

Fig. 2. Comparison of population densities of mosquitoes, their predators, and other animals in the four experiments.

species showed, generally, an increase as the predator larvae developed. The radio-activity of dytiscid adults rose from 61 to 640 cpm., and that of *L. indivisus* from 40 to 301 cpm.

Fig. 1 shows the relationship between the percentages of individuals of several predators that became radio-active and the advance of the season. The data, summarized from Table I, show that a progressively greater percentage of the predators fed on mosquitoes. The high percentage of radio-active dytiscids on April 14, in comparison with the other predators, may be attributed to the early appearance of the adults in the pools.

Estimations of the mosquito and predator populations revealed a decrease in density of mosquitoes and an increase in the density of their predators (Table II). The pupal density of 930 for mosquitoes on May 11 represents a decrease of approximately 40 per cent in comparison with the average of the densities on April 14 and 22, whereas the predator density increased during the same period from 0.49 to 70.0 per square metre; the percentage of animals in the ponds that became radio-active rose from 18.8 to 86.9, and the number of species that became radio-active rose from two to nine.

The relationships of mosquito, predator, and other animal densities are given in Fig. 2, which shows a decrease in the mosquito population density at the same time as the increase in the number of their predators.

Conclusions

The use of radio-phosphorus presents a new approach to the quantitative study of predation in the field. The technique was suggested by Jenkins and

TABLE II

Prey and predator densities, percentage of animals that became radio-active, and the number of predator species in the four experimental ponds

	Pond Number			
	I	II	III	IV
Date	April 14	April 22	May 5	May 11
Stage of growth of mosquitoes	third-instar larvae	third and fourth instar larvae	fourth instar larvae	pupae
No. of larvae made radio-active	4,300	9,100	3,800	3,500
Percentage of larvae activated	24.7	68.4	56.0	66.0
Estimate of mosquito population	17,400	13,300	6,800	5,300
Area of pond (square metres)	12.3	7.7	6.2	5.7
Mosquitoes per square metre	1,414	1,727	1,097	930
Animals other than mosquitoes per square metre	2.6	9.5	39	79
Predators of mosquitoes per square metre	0.49	1.8	12	70
Percentage of animals that became radio-active (Table I)	18.8	19.2	30.0	86.9
No. of predator species	2	6	6	9

Hassett (1950), but the use of a tracer in this work represents the first serious attempt to tag mosquito larvae and pupae and to identify their predators by testing them for radio-activity.

Another method of determining predation on mosquitoes is by means of precipitin reactions, as suggested by Brooks and Proske (1946), West (1950), and Hall *et al.* (1953). The precipitin tests show that a certain predator has or has not fed on a certain host insect. The radio-active technique, on the other hand, gives in addition an indication of the number of prey ingested by individual predators. An accurate assessment of predation by individuals is difficult, however, owing to the wide range of radio-activity of the mosquitoes released and differences in the feeding habits of the predators. The possibility of second-order predation must not be overlooked, but its importance in this study is considered negligible.

A number of new records of mosquito predators were established in these experiments, namely, *Limnephilus indivisus*, *Belostoma fluminea*, and *Gyrinus lecontei*. An interesting record is that of the trichopteran *L. indivisus*. Twinn (1931) recorded a psychomyid larva capturing several *Aedes* larvae and pupae in its net. Ross (1944) recognized that Limnophilidae are essentially plankton feeders, but they do take insect larvae. Downe and West (1954) stated that smears of caddisfly larvae collected at Churchill, Manitoba, gave positive reactions to anti-mosquito serum in precipitin tests.

Previous records of pond snail predation on mosquito larvae and pupae were confirmed. Bishop and Hart (1931) recorded the predacious habits of *S. palustris* on mosquito larvae and pupae in the laboratory and in the field. Downe and West (1954) also observed predation by snails in the field.

Summary

The prey-predator relationships of two species of mosquitoes at Chatterton, Ontario, were investigated by means of radio-phosphorus. Mosquito larvae and pupae were made radio-active with P^{32} and released in ponds on four dates; animals collected from the ponds a day later were tested for radio-activity. The results showed that several species of pond animals were predators of larvae and pupae. The importance of these predators in control was evident from the numbers that become radio-active and also from the high radio-activity of certain species, dytiscids and limnephilids being the most important. Three new records of mosquito predators were obtained. As the generations of pond animals developed, more predators fed on the mosquitoes. The resulting decrease in the population density of the mosquitoes coincided with the increase in the density of the predators.

Acknowledgements

The authors wish to thank Dr. A. Cipriani and Dr. C. A. Mawson of the Atomic Energy of Canada Limited, Chalk River, Ontario, for their keen interest and helpful criticisms. They are also indebted to officers of the Systematic Entomology Unit, Entomology Division, Ottawa, for identification of the insects, to Dr. L. S. Russell and his associates, the National Museum of Canada, Ottawa, for identification of most of the invertebrates other than insects, and to Dr. John Oughton, Ontario Agricultural College, Guelph, and the Rev. H. B. Herrington, Keene, Ontario, for assistance in the determination of molluscs. They also wish to thank Mr. Derek Riordan of the Belleville laboratory for assistance, particularly for designing a number of pieces of useful equipment.

References

Baldwin, W. F., H. E. Welch, and D. Riordan. In preparation. Some notes on the uptake of radio-phosphorus by mosquito larvae.

Bishop, F. C., and R. C. Hart. 1931. Notes on some natural enemies of the mosquito in Colorado. *J. New York Ent. Soc.* 39: 151-157.

Brooke, M. M., and H. O. Proske. 1946. Precipitin test for determining natural insect predators of immature mosquitoes. *J. Nat. Malaria Soc.* 5: 45-56.

Downe, A. E. R., and A. S. West. 1954. Progress in the use of the precipitin test in entomological studies. *Canadian Ent.* 86: 181-184.

Gerberich, J. B. 1946. An annotated bibliography of papers relating to the control of mosquitoes by the use of fish. *Amer. Midl. Nat.* 36: 87-131.

Hall, R. R., A. E. R. Downe, C. R. MacLellan, and A. S. West. 1953. Evaluation of insect predator-prey relationships by precipitin test studies. *Mosquito News* 13: 199-204.

Hinman, E. H. 1934. Predators of the Culicidae (mosquitoes). I. The predators of larvae and pupae, exclusive of fish. *J. Trop. Med. Hyg.* 37: 129-134.

Jenkins, D. W., and C. C. Hassett. 1950. Radioisotopes in entomology. *Nucleonics* 6: 5-14.

Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. *Illinois Nat. Hist. Surv. Bull.* 23.

Twinn, C. R. 1931. Observations on some aquatic animal and plant enemies of mosquitoes. *Canadian Ent.* 63: 51-61.

West, A. S. 1950. The precipitin test as an entomological tool. *Canadian Ent.* 82: 241-244.

Sawflies Collected from Low-Bush Blueberry Fields in New Brunswick (Hymenoptera: Tenthredinidae)[1]

By W. T. A. Neilson[2]
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As part of a comprehensive investigation on insects affecting the low-bush blueberry in New Brunswick, a study has been made since 1950 of the sawflies present in blueberry fields in Charlotte County. Of the 19 species collected by sweeping, only three *Neopareophora litura* (Klug), *Pristiphora idiota* (Nort.), and *Pristiphora* sp., feed on blueberry; the remainder feed on other plants growing in or near the blueberry fields. Blueberry sawflies are common in New Brunswick but do not cause any serious injury. However, in Maine, Phipps (1930, pp. 107-232) reported complete defoliation of 50 acres of blueberries by sawfly larvae.

The species of sawflies in the following list were collected from 1950 to 1953 and were identified by Dr. R. Lambert, Entomology Division, Ottawa; the host plants were determined by field observation (*) or were recorded from the literature (**).

Subfamily	*Species*	*Host*
Selandriinae	*Aneugmenus flavipes* (Nort.)	
Nematine	*Anoplonyx canadensis* (Hgtn.)	Larix (larch)**
	Neopareophora litura (Klug)	*Vaccinium myrtilloides* Michx. (low-bush blueberry)*

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[2]Assistant Entomologist.

Subfamily	*Species*	*Host*
		Vaccinium angustifolium Ait. (low-bush blueberry)*
	Pristiphora bivittata (Nort.)	*Spiraea latifolia* (Ait.) Borkh. (meadow-sweet)*
	Pristiphora geniculata (Htg.)	*Sorbus***
	Pristiphora idiota (Nort.)	*Vaccinium myrtilloides* Michx. (low-bush blueberry)*
		Vaccinium angustifolium Ait. (low-bush blueberry)*
		Vaccinium macrocarpon Ait. (American cranberry)**
	Pristiphora sp.	*Vaccinium myrtilloides* Michx. (low-bush blueberry)*
		Vaccinium angustifolium Ait. (low-bush blueberry)*
	Pachynematus sp. (*extensicornis* group)	Gramineae (grasses and sedges)**
	Nematus (*Pteronidea*) sp.	*Rhododendron canadense* (L.) Torr (rhodora)*
	Nematus (*Pteronidea*) *mendicus* Walsh.	*Salix* (willow)**
	Nematus (*Pontania*) sp.	*Populus* (poplar)*
	Nematus (*Pontania*) sp.	No record
Allantinae	*Ametastegia tener* (Fall.)	No record
Blennocampinae	*Pareophora* sp. (poss. *spiraea* Dyar)	*Spiraea salicifolia L.* (meadow-sweet)**
	Ardis sp.	No record
	Monophadnoides geniculatus (Hgt.)	*Rubus* (raspberry)**
Tenthredininae	*Rhogogaster californica* (Nort.)	No record
	Tenthredo xantha (Nort.)	No record
	Macrophya flavicoxae (Nort.)	No record

Reference

Phipps, C. R. 1930. Blueberry and huckleberry insects. *Maine Agr. Expt. Sta. Bull.* 356: 107-232.

(Received July 15, 1955)

Composite Emergence Cage for Studies on the Life-History of the Onion Maggot, *Hylemya antiqua* (Mg.) (Diptera: Anthomyiidae)[1]

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Field Crop Insect Section, Science Service Laboratory, St. Jean, Que.

In investigations on the life-history of the onion maggot, *Hylemya antiqua* (Mg.), at St. Jean, several types of emergence cages were devised and tested. The composite emergence cage described below was found very satisfactory for the collecting of adults.

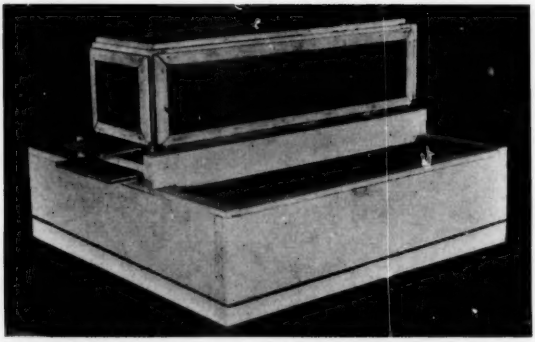

Fig. 1 Composite emergence cage, side view.

Description

The cage (Fig. 1) consists of three sections (Fig. 2) designated as follows: a transfer section (A), an emergence section (B), and a soil section (C). Fig. 2 gives side views of the sections and Fig. 3 shows them diagrammatically from the front. For the transfer section a wooden frame is covered with galvanized screen on the top, on the two rectangular sides, and on one end, the other end (Fig. 2,a) being covered with wood and the bottom being closed by a sliding board (c) fitting into a slot (b). For the emergence section a wooden frame supports a secondary frame (d) with a slot (f) for another sliding board (e), the rest of the top being covered with galvanized screen and the bottom being left open. The transfer section slides into the secondary frame of the emergence section. For the soil section a wooden frame is covered on the bottom with copper screen, the top being left open. The emergence section rests on the soil section.

Fig. 4 shows a cage used for collecting flies from the transfer section. This collecting cage is a wooden frame (g) covered with galvanized screen on two sides and closed in front by a sliding board (h) fitting into a secondary frame (i). The interior width of the secondary frame must be the same as the bottom width of the transfer section.

Operation

The cage without the soil section is set on the ground. Flies emerging from pupae in the soil are trapped in the emergence section. For the transfer

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of the flies, the sliding boards c and e (Fig. 1, 2) are pulled out, permitting free access from the emergence section to the transfer section. Heavy black cloth is set over the screened parts of the emergence section. The flies are attracted by light and promptly move from the darkened emergence section to the bright transfer section. The two sections are then closed by pushing inward the sliding board c and then the sliding board e. The transfer section containing the adults

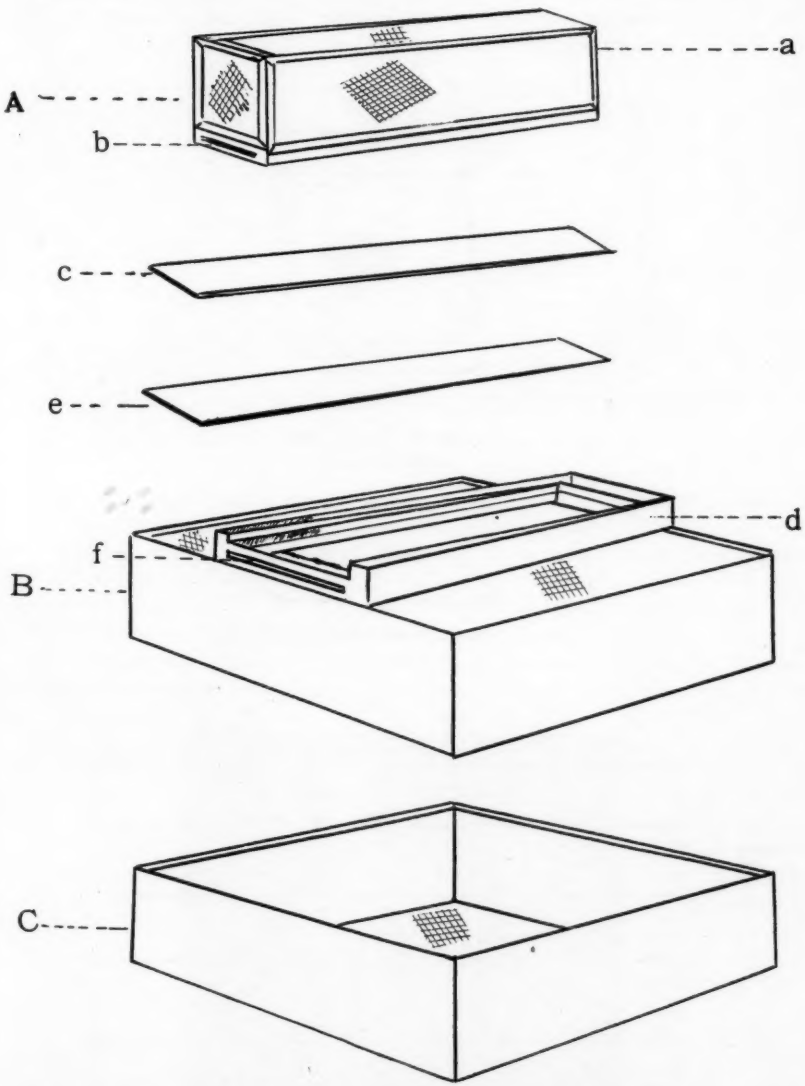

Fig. 2. Sectional diagram of cage: A, transfer section; B, emergence section; C, soil section. a, wooden part; b, slot; c, sliding board; d, secondary frame; e, sliding board; f, slot.

can then be removed. In some types of experiments, one transfer section may be used to capture flies from several emergence sections set in the same or in different fields.

To empty the transfer section, the collecting cage shown in Fig. 4 is used. The transfer section fits vertically into the secondary frame (i) of the collecting cage (Fig. 5). The sliding board h is pulled upward, and the sliding board c is pulled downward half-way. Tapping light on the transfer section causes the flies to move quickly into the collecting cage. It is not necessary to darken the transfer section, but the collecting cage should face the light.

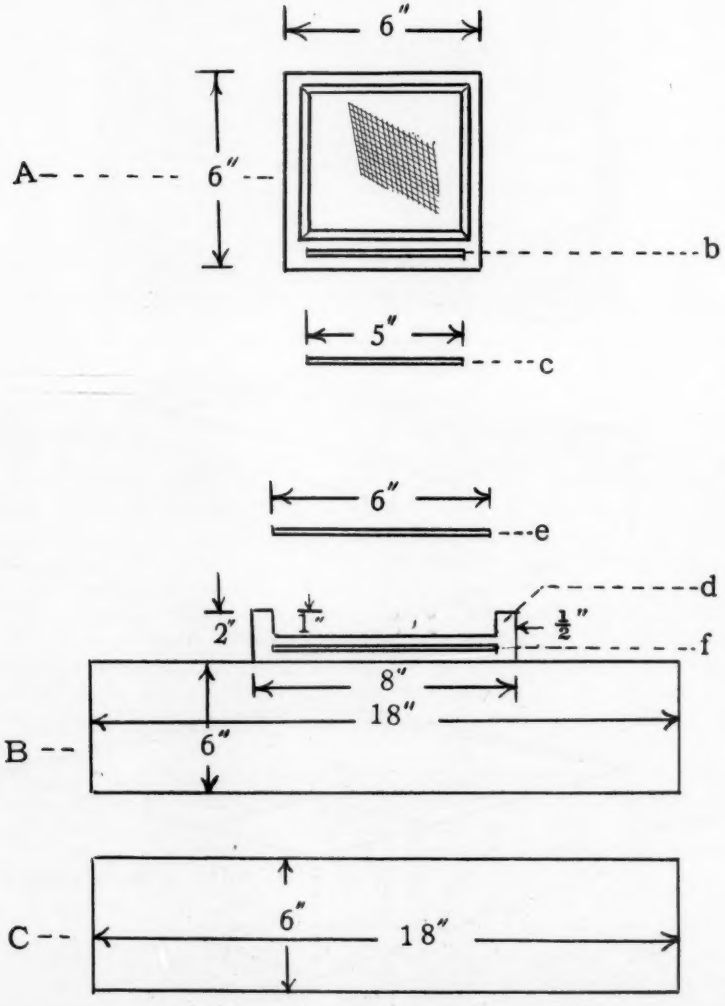

Fig. 3. Sectional diagram of front end of cage: A, transfer section; B, emergence section; C, soil section. b, slot; c, sliding board; d, secondary frame; e, sliding board; f, slot.

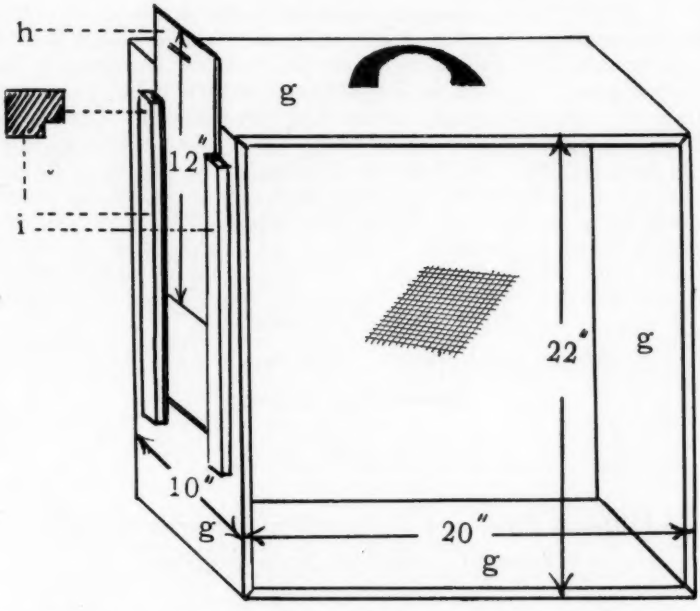

Fig. 4 Collecting cage: g, wooden frame; h, sliding board; i, secondary frame.

For studying the emergence of adults from pupae over-wintered in the soil, the soil section is buried in the fall so that the top edges of the section are even with the surface of the soil. Pupae are then buried in the soil section. Early the following spring, the emergence section is placed on the soil section. Adults emerging from the soil are trapped in the emergence section and may be collected as described above.

To determine the number of generations, the number of flies emerging and the number of pupae remaining in dormancy for each generation, and similar

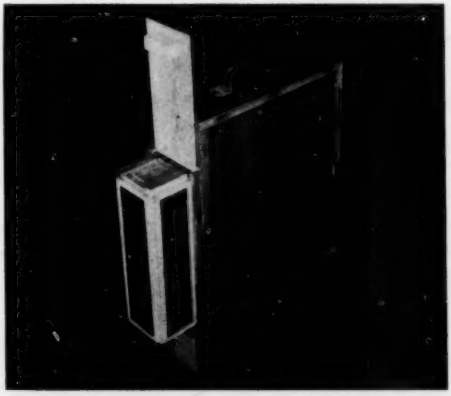

Fig. 5. Transfer section and collecting cage set up for transfer of adults from transfer section.

life-history data, the soil section may be buried early in the spring. Onion or another selected host is grown in the soil section. The plants, naturally or artificially infested with the insects, are covered with the emergence section before the emergence period of each generation throughout the growing season. The composite emergence cage may be made considerably larger in order to provide space for a larger number of plants. Such cages measuring 10 feet by 4 feet at the base have been used with success by the authors at Rougemont, Que. The large cages can be oriented in the field and the opening for the transfer section may be at the east end of the emergence section. Emerging flies will move to this end of the emergence section in the morning and can be collected at that time with the transfer section without the use of a black cloth. The opening for the transfer section may be made at the west end of the emergence section if flies are collected in the late afternoon.

The cage may be used for similar studies on other Diptera.

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Additional Host and Distribution Records of Some Eastern Canadian Siphonaptera

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The following records of Canadian Siphonaptera are supplementary to those detailed in Fox (1940), Ewing and Fox (1943), and Holland (1949, 1952). Records of fleas from the Maritime Provinces are particularly lacking in the literature, being limited to the following species:

NEW BRUNSWICK: *Ceratophyllus gallinae* (Schrank); *Epitedia wenmanni wenmanni* (Rothschild); *Hoplopsyllus glacialis lynx* (Baker); *Nearctopsylla genalis laurentina* Jordan and Rothschild; *Orchopeas caedens durus* (Jordan); *Oropsylla arctomys* (Baker); *Stenoponia americana* (Baker).

NOVA SCOTIA: *Ceratophyllus riparius* Jordan and Rothschild.

PRINCE EDWARD ISLAND: *Pulex irritans* (Linnaeus).

Most of the present records are from this area of Canada and increase our knowledge of the flea fauna of this region. Ten additional species are included from New Brunswick and three from Nova Scotia. One additional flea host (*Sorex arcticus*) is recorded for Canada.

The classification followed in this list is modified slightly from that of Holland (1949). The majority of the specimens listed are in the writer's collection; a few are deposited in the Canadian National Collection. In the lists of new Canadian records the collector's name follows in brackets. The writer is indebted to Mr. G. P. Holland, Systematic Entomology, Division of Entomology, Ottawa, who identified some of the specimens, checked the writer's identification of others, and offered helpful criticisms of the original manuscript of this paper.

Family *Pulicidae*
Subfamily *Spilopsyllinae*
Hoplopsyllus glacialis lynx (Baker)

One occurrence of this flea is recorded by Holland (1949) east of Alberta—a record from New Brunswick ex "hare". No subsequent records have been located in the literature.

New Canadian Record

NEW BRUNSWICK: Tay Falls, November 2, 1954, ex *Lepus americanus struthopus*, 1♀ (N. R. Brown).

Subfamily *Archaeopsyllinae*

***Ctenocephalides canis* (Curtis)**

Although this species is recorded as common along the Atlantic coast to Maine (Fox, 1940) and in Canada as far east as Quebec (Holland, 1949), there appear to be no records from New Brunswick.

New Canadian Records

NEW BRUNSWICK: Fredericton, June 29, 1948, ex dog, 4♀ (J. Clark); Fredericton, August 5, 1948, ex dog, 2♀ (F. E. Webb).

***Ctenocephalides felis felis* (Bouché)**

Fox (1940) records this common flea from most of the New England States. No records from the Maritime Provinces have been located in the literature.

New Canadian Records

NEW BRUNSWICK: Fredericton, October 6, 1947, ex cat, 7♀ (J. T. B. Kingston); Fredericton, summer 1949, ex dog, 3♂; Fredericton, August 15, 1949, ex dog, 1♀ (F. V. Royer); Fredericton, October 10, 1949, ex cat, 1♀ (W. E. Cawthray); Fredericton, November 26, 1950, ex dog, 1♂, 2♀ (C. G. Hadley).
NOVA SCOTIA: Middleton, August 15, 1949, ex cat, 1♀ (D. Etheridge).

Family *Hystrichopsyllidae*

Subfamily *Hystrichopsyllinae*

***Stenoponia americana* (Baker)**

Recorded as far north as Maine. In Canada old records are from Manitoba and Ontario. Morris (1943) records it from New Brunswick and Quebec (Gaspé).

New Canadian Records

QUEBEC: Laniel, August 26, 1942, ex *Peromyscus maniculatus gracilis*, 1♀ (N. R. Brown); Laniel, August 27, 1942, ex *Blarina brevicauda talpoides*, 1♀ (N. R. Brown).
NEW BRUNSWICK: Fredericton, October 24, 1953, ex *Peromyscus maniculatus abietorum* or *Clethrionomys gapperi ochraceus*, 1♂ (D. Bradshaw).

Subfamily *Neopsyllinae*

***Catallagia borealis* Ewing**

This species was first reported from Canada (Quebec) by Holland (1952).

New Canadian Records

NEW BRUNSWICK: Fredericton, October 24, 1953, ex *Clethrionomys gapperi ochraceus* or *Peromyscus maniculatus abietorum*, 1♀ (D. Bradshaw); Fredericton, December 6, 1953, ex *Clethrionomys gapperi ochraceus*, 1♀ (N. R. Brown).

***Epitedia wenmanni wenmanni* (Rothschild)**

This species has been recorded from many hosts in Canada as far east as Ontario. One record from an unknown host exists from New Brunswick (Holland, 1949). In U.S.A. the records extend north to Maine.

New Canadian Records

NEW BRUNSWICK: Stanley, November 12, 1951, ex *Tamiasciurus hudsonicus gymnicus*, 1♂ (N. R. Brown); Fredericton, December 6, 1953, ex *Peromyscus maniculatus abietorum*, 2♂ (N. R. Brown); Fredericton, December 6, 1953, ex *Clethrionomys gapperi ochraceus*, 4♀ (N. R. Brown).

One of the male fleas recorded from *P. m. abietorum* is unusual in having four lateral pairs of plantar bristles as well as a basal submedian pair on the fifth tarsal segment of the left metathoracic leg (Figure 1). Typically *Epitedia* does not have the basal submedian pair of bristles (Figure 2) and the right leg of the specimen in question was normal. Another genus in this subfamily, *Meringis*,

known in Canada only from *M. shannoni* (Jordan), has the tarsus like that of the atypical one described above on *E. wenmanni*.

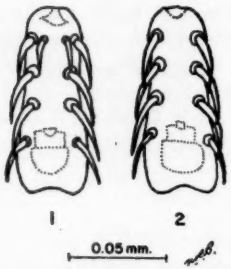

Fig. 1—*Epitedia w. wenmanni*, right metatarsus V of atypical specimen.
Fig. 2—*E. w. wenmanni*, typical metatarsus V.

Subfamily *Ctenophthalminae*
***Ctenophthalmus pseudagyrtes* Baker**

This species has not been previously recorded in Canada east of Ontario.

New Canadian Records

ONTARIO: Black Sturgeon Lake, Thunder Bay District, June 6, 1949, ex mouse, 1♂, 1♀ (W. E. Cawthray).

NEW BRUNSWICK: Nashwaaksis, January 18, 1949, ex *Tamiasciurus hudsonicus gymnicus*, 1♂ (N. R. Brown); Fredericton, December 6, 1953, ex *Clethrionomys gapperi ochraceus*, 2♀ (N. R. Brown); Fredericton, December 6, 1953, ex *Peromyscus maniculatus abietorum*, 1♂ (N. R. Brown).

NOVA SCOTIA: Garden of Eden, July 19, 1954, ex *Blarina brevicauda pallida*, 1♂, 1♀ (D. Bradshaw).

***Corrodopsylla curvata curvata* (Rothschild)**

This flea has not been previously recorded in Canada east of Ontario.

New Canadian Record

NOVA SCOTIA: Garden of Eden, July 21, 1954, ex *Sorex cinereus acadicus*, 1♂ (D. Bradshaw).

Subfamily *Nearctopsyllinae*
***Nearctopsylla genalis laurentina* Jordan and Rothschild**

Described from New Brunswick specimens on *Mustela* sp., this species has also been recorded in Canada from Ontario and Quebec.

New Canadian Record

NEW BRUNSWICK: West Sackville, April 7, 1950, ex *Sores arcticus* (prob. *maritimensis*), 1♀ (G. F. Boyer); Holland (1949) does not list any fleas on this host.

Family *Ceratophyllidae*
Subfamily *Ceratophyllinae*
***Orchopeas caedens durus* (Jordan)**

As noted in Holland (1949) the males of this species do not show reliable characters for the separation of subspecies. The only record from New Brunswick is apparently of 4♂ and 2♀ with no data, determined as *O. c. durus*. As the present females are this subspecies and the localities are far removed from the known range of *O. c. caedens*, the males are included with them.

New Canadian Records

NEW BRUNSWICK: Nashwaaksis, January 18, 1949, ex *Tamiasciurus hudsonicus gymnicus*, 2♂, 3♀ (N. R. Brown); Penniac, October 30, 1950, ex *Tamiasciurus hudsonicus gymnicus*, 1♀ (N. R. Brown); Scotch Lake, November 30, 1950, ex *Tamiasciurus hudsonicus gymnicus*, 5♂, 4♀ (N. R. Brown); Stanley, November 12, 1951, ex *Tamiasciurus hudsonicus gymnicus*, 3♂, 4♀ (N. R. Brown).

***Orchopeas leucopus* (Baker)**

This species has been recorded in all Canadian provinces east to Quebec from many different rodent hosts. No previous records exist from the Maritime Provinces.

New Canadian Records

NEW BRUNSWICK: Fredericton, December 6, 1953, ex *Peromyscus maniculatus abietorum*, 1♀ (N. R. Brown); Fredericton, December 6, 1953, ex *Peromyscus maniculatus abietorum* or *Clethrionomys gapperi ochraceus*, 1♀ (N. R. Brown).

***Ceratophyllus diffinis* Jordan**

In Canada this species has not been previously recorded east of Ontario. Records in U.S.A. extend north to New Hampshire.

New Canadian Record

NEW BRUNSWICK: Fredericton, June 9, 1950, ex *Bonasa umbellus togata*, 2♂ (N. R. Brown).

***Megabothris asio asio* (Baker)**

This species has been recorded in Canada from Ontario and Quebec.

New Canadian Record

NEW BRUNSWICK: St. Andrews, 1952, ex *Mustela* sp., 1♂ (B. Mackenzie).

***Monopsyllus vison* (Baker)**

Recorded in Canada east to Quebec and in U.S.A. north to Maine.

New Canadian Records

NEW BRUNSWICK: Green River, August 10, 1948, ex squirrel (prob. *Tamiasciurus hudsonicus* ssp.), 1♂ (A. D. Brown); Scotch Lake, November 30, 1950, ex *Tamiasciurus hudsonicus gymnicus*, 1♀ (N. R. Brown); Stanley, November 12, 1951, ex *Tamiasciurus hudsonicus gymnicus*, 1♂ (N. R. Brown).

Subfamily *Leptopsyllinae*

***Peromyscopsylla catatina* (Jordan)**

This species has been recorded in Canada only from Ontario. In U.S.A. records extend north to Maine.

New Canadian Record

NEW BRUNSWICK: Fredericton, December 6, 1953, ex *Clethrionomys gapperi ochraceus*, 1♂, 1♀ (N. R. Brown).

References

Ewing, H. E., and I. Fox. The fleas of North America. *U.S.D.A. Misc. Publ.* No. 500. 1943.
Fox, I. Fleas of Eastern United States. *Iowa State College Press.* 1940.
Holland, G. P. The Siphonaptera of Canada. *Canada, Dept. Agr., Tech. Bull.* 70. 1949.
Holland, G. P. Notes on some Siphonaptera from Canada. *Canadian Ent.* 84(3): 65-73. 1952.
Morris, R. F. The small forest mammals of New Brunswick and the Gaspé. *Acadian Nat.* 1(1): 27-42. 1943.

Mites (Anoetidae), Fungi (*Empusa* spp.) and Pollinia of Milkweed (*Asclepias syriaca*) Transported by Calyptrate Flies[1]

By W. W. Judd[2]

During the period April 13 to November 10, 1953 the writer conducted a survey of calyptrate flies of medical importance at London, Ontario, and its vicinity. The flies were trapped in twelve traps baited with malt extract and set out in twelve localities such as garbage dumps, the border of swamps and the premises of meat packing plants, sewage disposal plants, dairies, restaurants and industrial properties. During the course of the survey 142,975 flies in the families Anthomyiidae, Muscidae, Calliphoridae and Sarcophagidae were collected. From these were chosen twenty species for counting. The daily catch of these flies from each of the twelve traps was kept separate and the flies were sorted according to species and sex and a record was kept of the numbers of each species captured in each trap. In making the identifications it was necessary to examine each specimen under a binocular microscope and during this process the specimen was also examined for the presence on it of parasites or other organisms clinging to it. Three such organisms were found on several flies: mites, pollinia of milkweed and fungi of the genus *Empusa*.

Mites

Ten flies were found bearing deutonymphs, or travelling forms, of mites of the family Anoetidae. The ten flies were sent to Dr. E. W. Baker, United States Department of Agriculture, who kindly identified the mites as *Anoetus muscarum* (L.) and *Bonomoia* sp (near *sphaerocerae* Vitzthum). Microscope slide mounts were made of the mites and some of these slides were deposited in the United States National Museum. Three slides are deposited in the collection of the Department of Zoology, University of Western Ontario, and the numbers of these slides are recorded among the data in the following account.

Anoetus muscarum (L.)

Nymphs of *Anoetus muscarum* were found on eight specimens of the non-biting stable fly, *Muscina stabulans* (Fallen) (Fig. 1). They were present over the surface of the thorax and abdomen, mainly on the dorsal region. The estimated numbers of mites on each of the flies was as follows:

Fly 1 (June 3, trap 9): 50 mites
Fly 2 (June 13, trap 5): 200 mites (slide E21.43)
Fly 3 (June 13, trap 7): 150 mites (Fig. 1)
Fly 4 (June 13, trap 9): 200 mites (slide E21.42)
Fly 5 (June 15, trap 5): 30 mites
Fly 6 (July 17, trap 3): 750 mites
Fly 7 (Sept. 9, trap 6): 150 mites
Fly 8 (Sept. 9, trap 6): 200 mites

Where few mites were present, as on flies 1 and 5, they were scattered over the surface of the fly and where present in large numbers, as on fly 6, they obscured the whole surface of the thorax and abdomen. They were not strongly attached to a fly's body by their appendages or mouth parts and could easily be dislodged by scraping with a pin.

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[1]Contribution from the Department of Zoology, University of Western Ontario; a project supported by funds from the government of Ontario on recommendation of the Advisory Committee on Fisheries and Wildlife of the Research Council of Ontario.

[2]Associate Professor of Zoology.

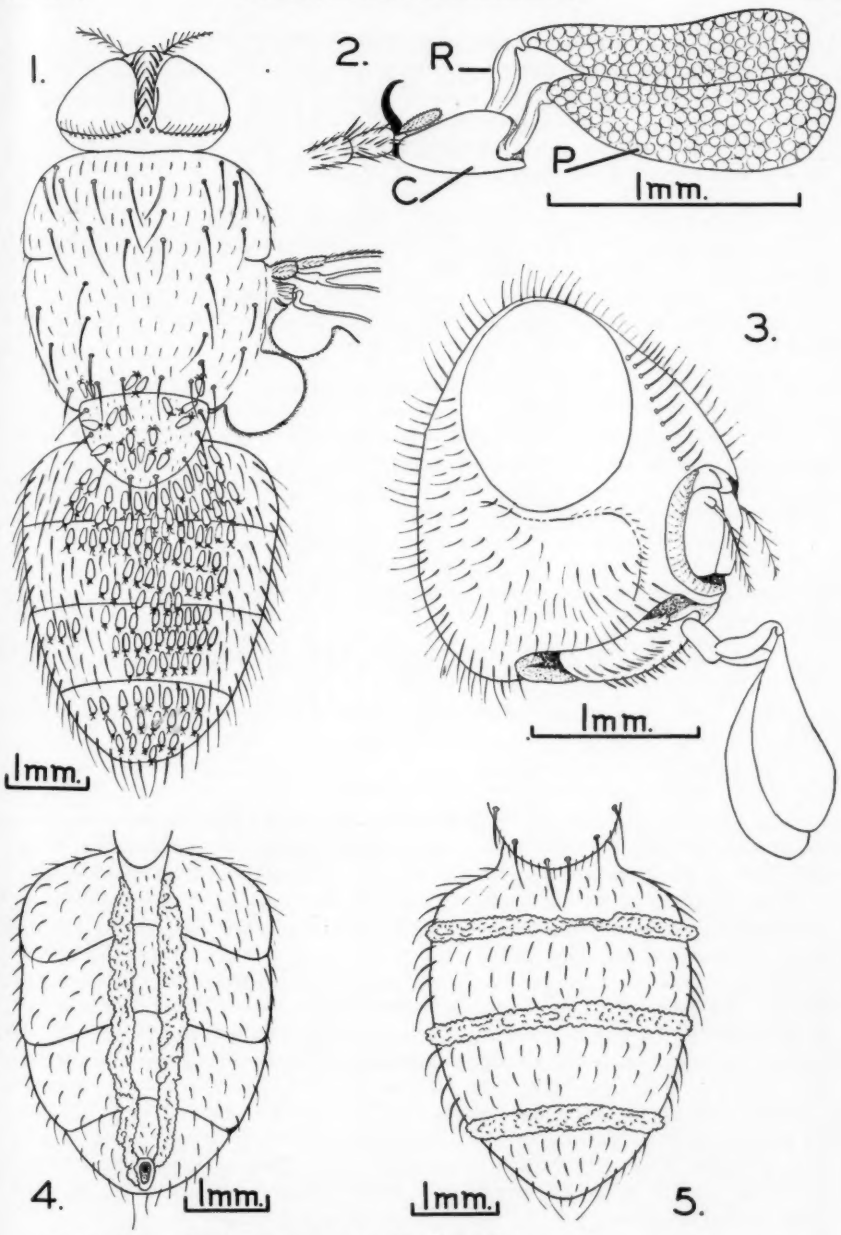

Fig. 1. Mites, *Anoetus muscarum*, on *Muscina stabulans*.
Fig. 2. Pollinia of milkweed attached to the foot of *Phormia regina*. C: corpusculum, P: pollinium, R: retinaculum.
Fig. 3. Pollinia of milkweed attached to the labellum of *Protophormia terrae-novae*.
Fig. 4. Bands of conidiophores of *Empusa muscae* on the abdomen (ventral view) of *Musca domestica*.
Fig. 5. Rings of conidiophores of *Empusa* (*americana?*) on the abdomen (dorsal view) of *Pollenia rudis*.

***Bonomoia* sp. (near *sphaerocerae* Vitz.)**

Deutonymphs of *Bonomoia* sp. (near *sphaerocerae*) were found on two specimens of the house fly, *Musca domestica* L. both of which were caught in trap 5 on June 8. Both flies bore about 100 mites (Slide E21.44).

Adult mites of the family Anoetidae frequent damp media such as rotting vegetable matter and the deutonymphs are regularly found on insects.

Pollinia of Milkweed

Six flies were found bearing pollinia of the common milkweed, *Asclepias syriaca* (Fig. 2, 3). The pollinia (P) of this plant are attached in pairs by retinacula (R) to a median body or corpusculum (C) and the corpusculum becomes clamped over the appendages of insects visiting the flowers. The distribution of pollinia on the six flies was as follows:

Calliphoridae:

Phormia regina (Meigen)–

Fly 1 (July 10, trap 3): corpusculum, with 2 pollinia, clamped over a pulvillus and claw of the left prothoracic leg (Fig. 2).

Fly 2 (July 26, trap 4): corpusculum, with 2 pollinia, wedged between the metathorax and abdomen on the left side.

Protophormia terrae-novae (Robineau-Desvoidy) –

Fly 3 (July 23, trap 6): corpusculum, with 2 pollinia, clamped over the claws of the right metathoracic leg; corpusculum, with two pollinia, clamped over labellum.

Fly 4 (July 23, trap 6): the pulvillus below each claw of the right prothoracic leg bearing a corpusculum with 2 pollinia.

Fly 5 (July 25, trap 5): corpusculum, with 2 pollinia, clamped over labellum (Fig. 3).

Sarcophagidae:

Wohlfahrtia vigil (Walker) –

Fly 6 (July 14, trap 4): corpusculum, with 2 pollinia, clamped over the pulvillus beneath one claw of the right mesothoracic leg; the pulvillus below each claw of the left mesothoracic leg bearing a corpusculum with 2 pollinia.

The structure of the flower of *Asclepias syriaca* and the role played by insects in the transfer of pollinia from one flower to another have been described by several authors including Müller (1883) and, more recently, Matheson (1951). An insect in search of nectar in the nectaries slips on the sides of the flower and gets the claws of its foot stuck in a slit between two adjacent anther wings. At the top of the slit is the corpusculum of the pollinial apparatus. As the insect draws its foot up the slit the corpusculum clamps over a claw of the foot and when the insect yanks its foot free from the slit it carries away the corpusculum and its two attached pollinia. When freshly removed from a flower the pollinia on a corpusculum are widely divergent but during subsequent drying they converge to lie side by side and when the fly carrying them visits another flower they easily penetrate the slit between the anther wings and are left near the stigma of the flower.

Müller (1883) lists several insects which carry pollinia of *Asclepias*, including blowflies of the genus *Lucilia*. He refers to the attachment of the corpusculum to the legs of insects but makes no reference to their attachment to the labellum of the labium as described by the present writer (Fig. 3). Ford (1936) studied the habits of the flesh fly, *Wohlfahrtia vigil*, in the vicinity of Toronto, Ontario and found flies of this species carrying pollinia of milkweed

on July 12, 1933 and July 20 and 26, 1935. All the flies found bearing pollinia at London in 1953 were trapped during July at traps, 3, 4, 5 and 6. There was a considerable growth of *Asclepias syriaca* near traps 3, 4 and 5 which were located on the outskirts of London, but no plants were found near trap 6 which was located in the business district of the city.

Fungi

Six flies were found bearing rings or bands of conidiophores bulging from between the segments of the abdomen (Fig. 4, 5). The flies were sent to Mr. S. T. Hughes, Division of Botany and Plant Pathology, Department of Agriculture, Ottawa, who identified the fungi as *Empusa muscae* Cohn and *Empusa* (*americana* Thaxter?). The distribution of the fungi on the six flies was as follows:

Empusa muscae Cohn:

Fly 1—*Musca domestica*, trap 9, August 4 (Fig. 4).

Fly 2—*Musca domestica*, trap 5, Sept. 28.

Fly 3—*Musca domestica*, trap 5, Sept. 29.

Fly 4—*Muscina stabulans*, trap 2, July 9.

Empusa (*americana* Thaxter?):

Fly 5—*Pollenia rudis* (Fabricius), trap 3, July 21 (Fig. 5).

Fly 6—*Pollenia rudis*, trap 5, Sept. 29.

On some of the flies the growth of conidiophores appeared as rings bulging from between the terga of the abdomen (Fig. 5), on some the conidiophores appeared as bands between the terga and sterna (Fig. 4) and on some both rings between the terga and bands between the terga and sterna were present. Mr. Hughes reported that the specimens of *E. muscae* bore conidia which were pointed at the apex and measured (19.5-24) × (24.2-30.7) microns and that rhizoids were absent. These features are in keeping with the description of *E. muscae* by Thaxter (1888) who reports this fungus as infesting *Musca domestica* and the blowflies *Lucilia caesar* and *Calliphora vomitoria*. On the specimens of *Empusa* (*americana?*) rhizoids were present and the conidiophores bore conidia which lacked the pointed apex and measured (16.5-19.5 × 24-29) microns. The presence of rhizoids and the shape of the conidia are in keeping with Thaxter's description of *E. americana* but the size of the conidia differ from those included in Thaxter's description. Thaxter records *Empusa americana* from *Musca domestica* and blowflies.

Acknowledgment

The writer gratefully acknowledges the assistance of Mr. J. B. Hartley who aided throughout 1953 in collecting, sorting and counting flies during the course of the survey.

References

Ford, N. 1936. Further observations on the behaviour of *Wohlfahrtia vigil* (Walk.) with notes on the collecting and rearing of the flies. *Jour. Parasitol.*, 22: 309-328.

Matheson, R. 1951. Entomology for introductory courses. 2nd. ed. Comstock Publ. Co., Ithaca.

Müller, H. 1883. The fertilization of flowers. McMillan Co., London.

Thaxter, R. 1888. The Entomophthoreae of the United States. Memoirs Boston Soc. Nat. Hist., 4: 133-201.

(Received April 5, 1955)

A Cabinet For Aseptic Manipulations[1]

By W. G. FRIEND[2]

Vegetable Insect Section, Entomology Laboratory Ottawa, Ontario

Attempts to rear plants and animals under aseptic conditions have led to the development of special cabinets in which the atmosphere can be sterilized and the experimental materials manipulated without fear of contamination. The mechanical design, instrumentation, and principles upon which the development of such equipment is based have been admirably discussed by Reyniers (1943). House and Patton (1949) made an ingenious modification of Reyniers' cabinet whereby it can be used to anaesthetize, handle, and weigh cockroaches aseptically.

The cabinet shown in the accompanying figures is another modification of Reyniers' basic model, the general shape and design of his cabinet being retained. The cabinet consists of a box 37 inches long, 25 inches wide, and 29 inches high, equipped with two large plate glass windows (Figs. 1-3). One of the windows is clamped against a rubber gasket and can easily be removed to facilitate cleaning the inside of the cabinet.

A box 13 inches on each side with a tightly fitting, sliding door at each end is attached to one end of the cabinet (Fig. 2). It acts as an air lock and through it objects can be introduced into the cabinet without opening the cabinet directly to drafts of contaminated air.

A 16-inch fluorescent lamp and a 16-inch ultra-violet lamp are mounted in the top of the cabinet, with individual wiring. The ultra-violet radiations are used to sterilize the air in the cabinet. A red warning light is illuminated when the ultra-violet tube is switched on because ultra-violet light can damage the eyes of the operator.

In Reyniers' cabinet long rubber gloves were clamped, by means of metal rings, into the two arm holes in each side of the cabinet. This made the cabinet practically air tight and there was no way that air-borne microorganisms could enter. The author soon found that many manipulations requiring a delicate touch were impossible when thick rubber gloves were worn. To circumvent this difficulty, the rubber gloves were discarded and sterile air is pumped into the cabinet at the rate of four cubic feet per minute.

The only way that this sterile air can escape is through the arm holes. The flow of air from the inside of the cabinet out the arm holes blocks the entry of microorganisms. The air pumped into the cabinet is sterilized by a filter consisting of two tubes of two-inch pipe, 25 inches long, connected by a 5/8 inch pipe. Air entering the top of one of the two-inch pipes passes down, enters the 5/8 inch pipe, and is carried up to the top of the other two-inch pipe; then it passes down the second two-inch pipe, through a short piece of rubber tubing, and into the cabinet (Fig. 3). Both two-inch pipes are packed with number 800 Pyrex glass filtering wool. Before use, the glass wool in the tubes is soaked with a mixture of five parts of S.A.E. 30 motor oil and 95 parts of petroleum ether. The petroleum ether is removed by vacuum, leaving the glass fibres coated with a thin film of oil that traps the microorganisms carried into it by the air stream. The filter is sterilized by autoclaving and then connected in the air line between the compressor and the cabinet. The air passing through the filter

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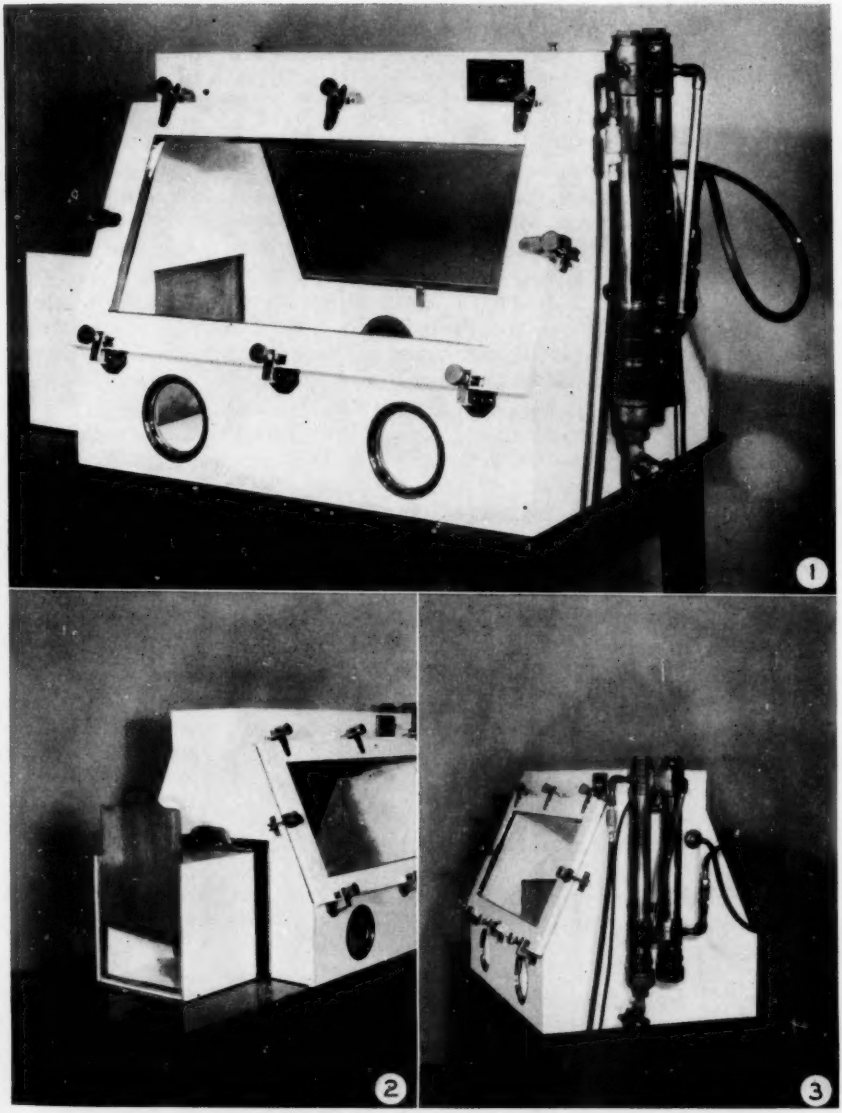
[2]Associate Entomologist.

is baffled as it enters the cabinet to prevent the formation of strong air currents. When not in use, the arm holes are tightly plugged and the ultra-violet light is turned on for six to 12 hours to sterilize the interior of the cabinet.

This cabinet has been used for the aseptic manipulation of insect and plant material with great success. Even in very draughty situations the average contamination is less than one per cent.



Figs. 1-3. Aseptic cabinet. 1, Front view. 2, End view showing air lock. 3, End view showing air filter and attachments.

Acknowledgements

The author wishes to thank Messrs. G. Samson and C. Jackson of the Entomology Engineering Shop, Entomology Laboratory, Ottawa, for their expert help in designing and constructing the cabinet herein described.

References

House, H. L. and R. L. Patton. 1949. Nutritional studies with *Blattella germanica* (L.) reader under aseptic conditions. I. Equipment and technique. *Canadian Ent.* 81: 94-100.

Reyniers, J. A., ed. 1943. Micrurgical and germ-free methods. 1st ed. Charles C. Thomas, Springfield, Ill.

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ERRATUM

The mailing date of the July 1955 number was erroneously given as July 15, 1955. This should be changed to August 26, 1955.

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